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A preliminary report on the Eocene mammals of the Pondaung fauna, Myanmar

Takehisa Tsubamoto[1], Naoko Egi[2], Masanaru Takai[3], Nobuo Shigehara[3], Aye Ko Aung[4], Tin Thein[5], Aung Naing Soe[6] and Soe Thura Tun[4]

[1]*Department of Geology and Mineralogy, Graduate School of Science, Kyoto University, Kyoto 606-8502, Japan*
[2]*Department of Geology, National Science Museum of Japan, 3-23-1 Hyakunin-cho, Shinjuku, Tokyo 169-0073, Japan*
[3]*Primate Research Institute, Kyoto University, Inuyama 484-8506, Japan*
[4]*Department of Geology, Dagon University, Yangon, Myanmar*
[5]*Department of Geology, University of Pathein, Pathein, Myanmar*
[6]*Department of Geology, University of Yangon, Yangon, Myanmar*

Abstract

A diverse array of mammalian species is now known from the Pondaung Formation, located in central Myanmar. The new mammals for the Pondaung fauna are: Anthropoidea gen. *et* sp. nov. (Primates); Hyaenodontidae indet. A, and indet. B (Creodonta); ?Phiomyidae indet. C (Rodentia); Ungulata indet. D; ?Agriochoeridae indet. E (Artiodactyla); cf. *Ilianodon* (Rhinocerotoidea; Perissodactyla); Amynodontidae indet. F (Perissodactyla). The stratigraphical and microfossil evidences suggest that the Pondaung Formation is referable to the period from the middle to late Eocene. Concerning the dating of the Pondaung mammal fauna, middle middle to late Eocene (most probably late middle Eocene) is suggested based on comparisons of it with other Eocene mammal fauna; however, further information is necessary to identify the date more precisely.

Introduction

Fossil mammals from the Eocene Pondaung Formation in central Myanmar were firstly described by Pilgrim and Cotter (1916), and later by Pilgrim (1925, 1927, 1928) and Colbert (1937, 1938). Though this fauna has not been studied since 1938 by Colbert, it has been catching many researchers' attention because of the primate fossils, possibly one of the earliest anthropoids, which are older than the ones from the Fayum deposits in Egypt (e.g. Ba Maw *et al.*, 1979; Ciochon *et al.*, 1985; Jaeger *et al.*, 1998, 1999). Different from the majority of other Asian Paleogene deposits with mammalian fossils, the age of

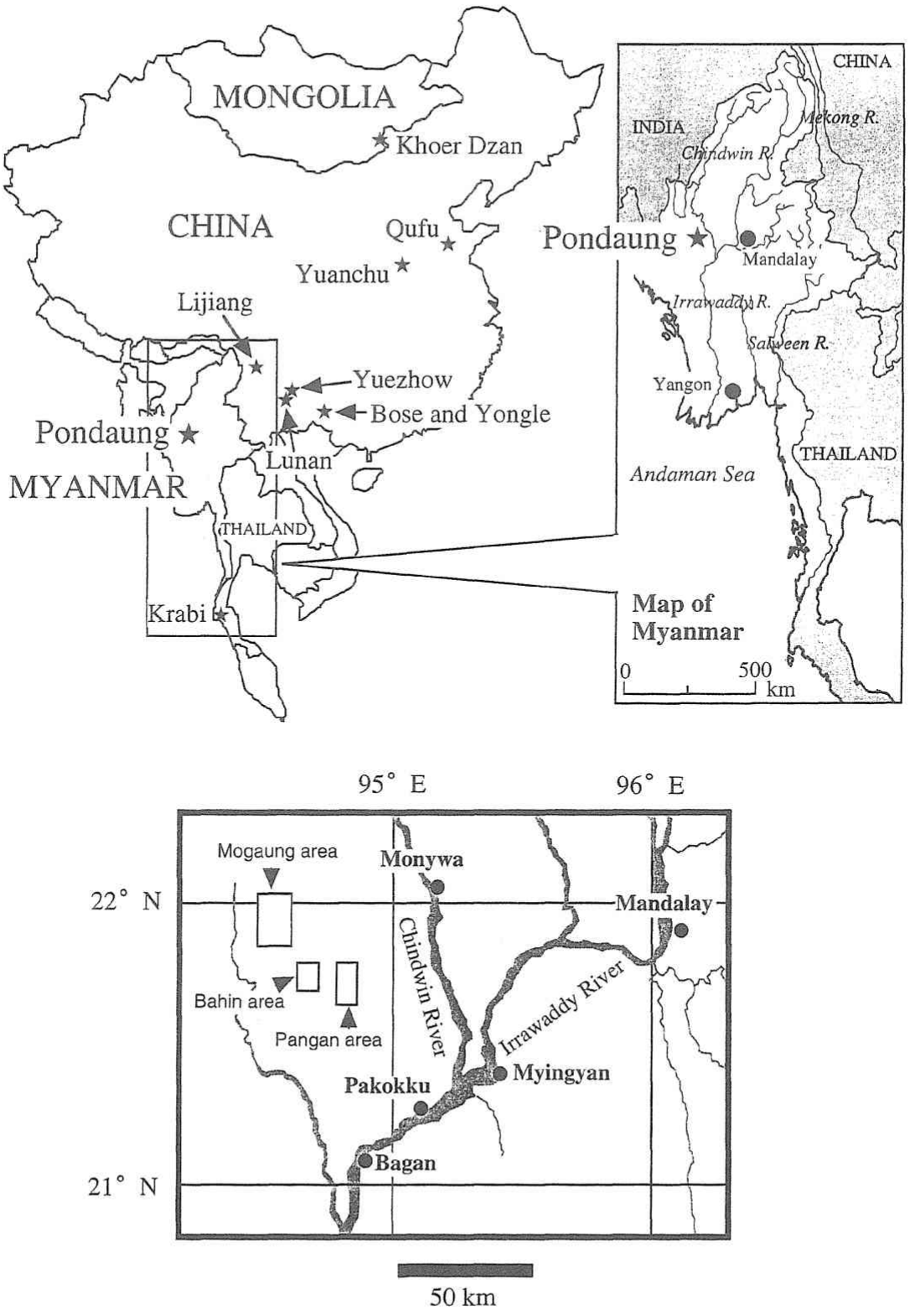

Figure 1. Location of fossil deposits mentioned in this paper. Upper left figure, the Pondaung Formation and other middle to late Eocene deposits in East Asia. Upper right figure, the Pondaung Area in Myanmar. Lower figure, Eocene vertebrate fossil bearing area in the Pondaung Area.

the Pondaung Formation has been estimated to some extent using the marine fossils which were found in formations located above and below the Pondaung Formation.

A number of additional Pondaung fossils was discovered by Myanmar researchers in 1997 (Pondaung Fossil Expedition Team, 1997), and by Myanmar-Japan Joint Fossil Expedition Team in 1998 and 1999. These new findings included some new and important taxa for the Pondaung Formation, such as rodents, creodonts and possible agriochoerid. In this paper, we preliminary report new mammalian fossils and taxa from the Pondaung Formation and compare the Pondaung mammal fauna with other contemporaneous faunas from southeastern Asia.

All new material are stored in the National Museum of the Union of Myanmar, in Yangon. Specimen numbers of these new material that we use start from NMMP-KU. "NMMP" means National Museum, Myanmar, Paleontology, and "KU" means Kyoto University (Japan).

Other abbreviations used are: AMNH = American Museum of Natural History, in New York, USA; UCMP = Museum of Paleontology, University of California, in Berkeley, USA; C.M. = Carnegie Museum, in Pittsburgh, USA; GSI = Geological Survey of India, in Calcutta, India; IVPP = Institute of Vertebrate Paleontology and Paleoanthropology, in Beijing, China.

Geological setting

The geological structure of Myanmar can be divided into four main parts each of which extends from north to south (Ba Than Haq, 1981). From east to west in order, those are: 1) the Shan-Tenasserim massif, which is Precambrian to Cretaceous; 2) the Central Irrawaddy Lowland, which is mainly composed of Cenozoic; 3) the Naga-Arakan mountain belt, which is Cretaceous to Miocene; and 4) the Coastal Arakan lowland, which is Cretaceous to recent (Ba Than Haq, 1981). The Pondaung Formation locates in central part of the Central Irrawaddy Lowland (Figure 1).

The Eocene geological section and generalized schematic diagram summary of the stratigraphy of the Pondaung area are shown in Figures 2 and 3, respectively. The Pondaung Formation overlies the Tabyin Formation and is overlain by the Yaw Formation.

The Tabyin Formation (Tabyin Clay) mainly consists of marine clay, yielding *Nummulites acutus*, an index fossil for middle Eocene age. It gradually changes upwardly into the Pondaung Formation, and in part, these two interfinger with one another (Bender, 1983).

The Pondaung Formation (Pondaung Sandstones) is about 2,000 m thick at the type section (Aye Ko Aung, 1999), and the thickness decreases toward the south (Stamp, 1922). It consists of alternation of mudstone, sandstone and conglomerate, and is subdivided to

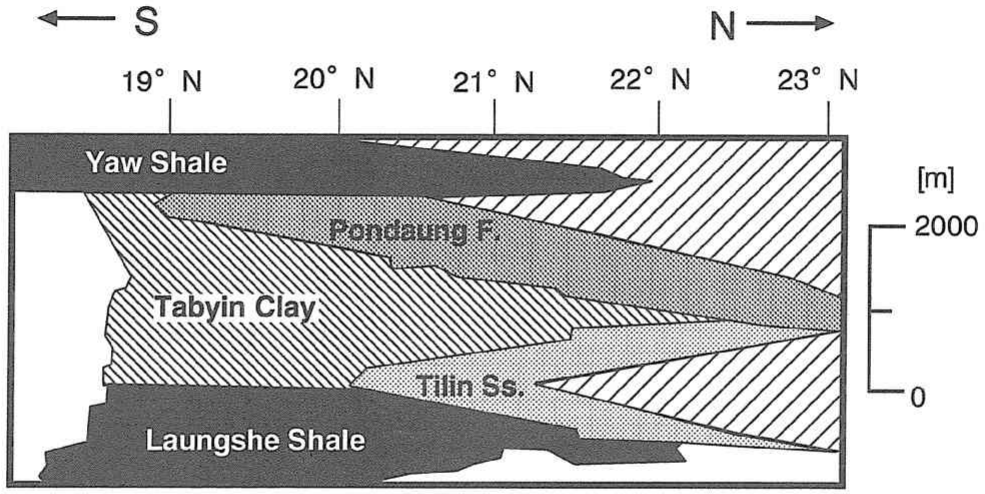

Figure 2. Generalized schematic diagram summary of the stratigraphy of the Eocene deposits in central Myanmar. The data are from Stamp (1922), Eames (1951), Bender (1983), Holroyd and Ciochon (1994), and Aye Ko Aung (1999).

"Lower" and "Upper" members (Aye Ko Aung, 1999). The "Lower Member" is about 1,500 m thick at the type section (Aye Ko Aung, 1999), and is dominated by greenish sandstone and conglomerate, containing marine molluscs occasionally (Bender, 1983). The "Upper Member" is about 500 m thick in the type section (Aye Ko Aung, 1999), and is dominated by variegated clay and contains many mammalian and other vertebrate fossils, indicating freshwater lagoon environment (Colbert, 1938; Bender, 1983; Aye Ko Aung, 1999; Aung Naing Soe, 1999). No marine index fossil has been found from the Pondaung Formation.

The Yaw Formation (Yaw Shale or Yaw Stage) conformably overlies the Pondaung Formation with a distinct lithological break (Bender, 1983; Aye Ko Aung, 1999). The Yaw Formation mainly consists of marine shale, containing the macroforaminifera *Nummulites yawensis*, *Discocyclina sella*, *Operculina* cf. *canalifera* and rich molluscan faunas with *Velates perversus* of late Eocene age (Bender, 1983; Aye Ko Aung, 1999).

The present material were discovered from the middle part of the "Upper Member" of the Pondaung Formation. The age of the Pondaung Formation has been considered as from middle to late Eocene on the basis of the ages of the underlying Tabyin Formation and the overlying Yaw Formation (Bender, 1983).

The currently known fossil sites are scattered roughly in three main areas in a long and thin region that extends about 50 km in a northwest to southeast direction (Figures 1, 4-7). Although the stratigraphical relationships among these fossil sites are unclear, the middle part of the "Upper Member" of the Pondaung Formation has been identified at all of these sites. Here, the mammalian fossils from all of these sites are treated as members of the Pondaung mammal fauna.

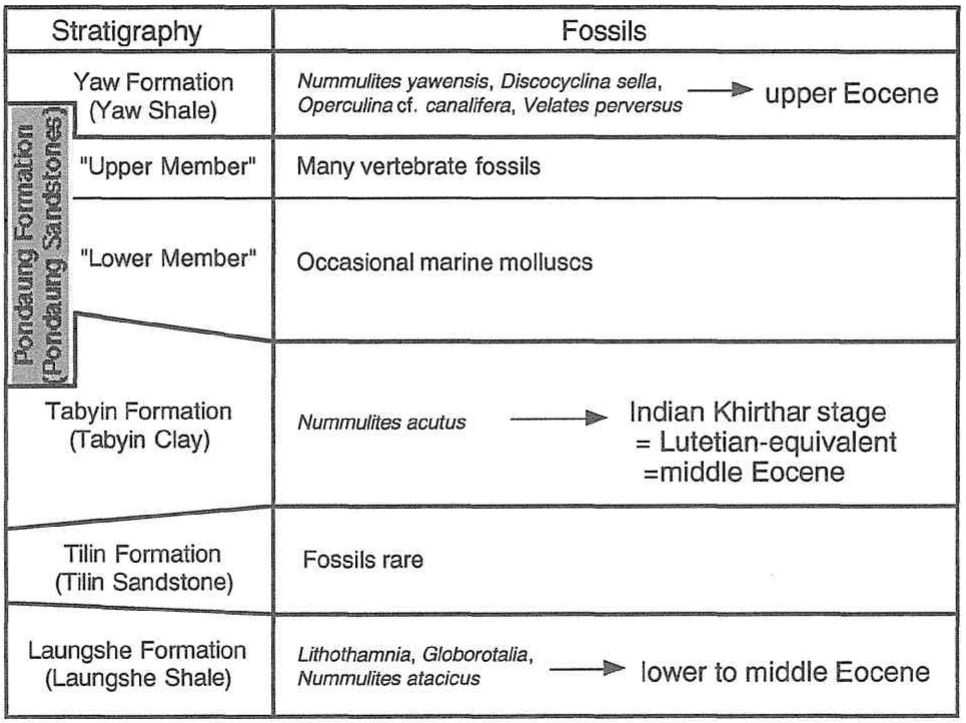

Figure 3. Eocene geological section of the stratigraphy of the Eocene deposits in central Myanmar (after Stamp, 1922; Holroyd and Ciochon, 1994).

Fossil locality information

In this section, we provide some information of the fossil localities, where the expedition was carried out during our field season in 1998 and 1999. Short comments on several localities are given with the latitude and longitude measured by global positioning system (GPS: Garmin GPS II), wherever available.

1. Bahin area (Figures 1, 4, 5)

Bahin area is located about 25 - 30 km north west from Myaing. The base camp for the expedition was settled at Tanaunggon Village (GPS data: N 21° 43' 41.0", E 94° 40' 43.7") in 1998, and at Bahin Village in 1999.

1-1. Bh1 (GPS data: N 21° 44' 13.3", E 94° 38' 13.1") (Figure 5): This locality is also called Yashe Kyitchaung, and is one of the most fossiliferous locality. Many fossils are discovered particularly in 1998. We visited this site on 6, 7 and 11 November 1998, and 13 November 1999.

1-2. Bh2 (GPS data: N 21° 44' 23.8", E 94° 38' 00.4") (Figure 5): We visited this site on 7 November 1998, and 13 November 1999.

1-3. Bh3 (GPS data: N 21° 44' 19.6", E 94° 38' 10.4") (Figure 5): We visited this site on 7

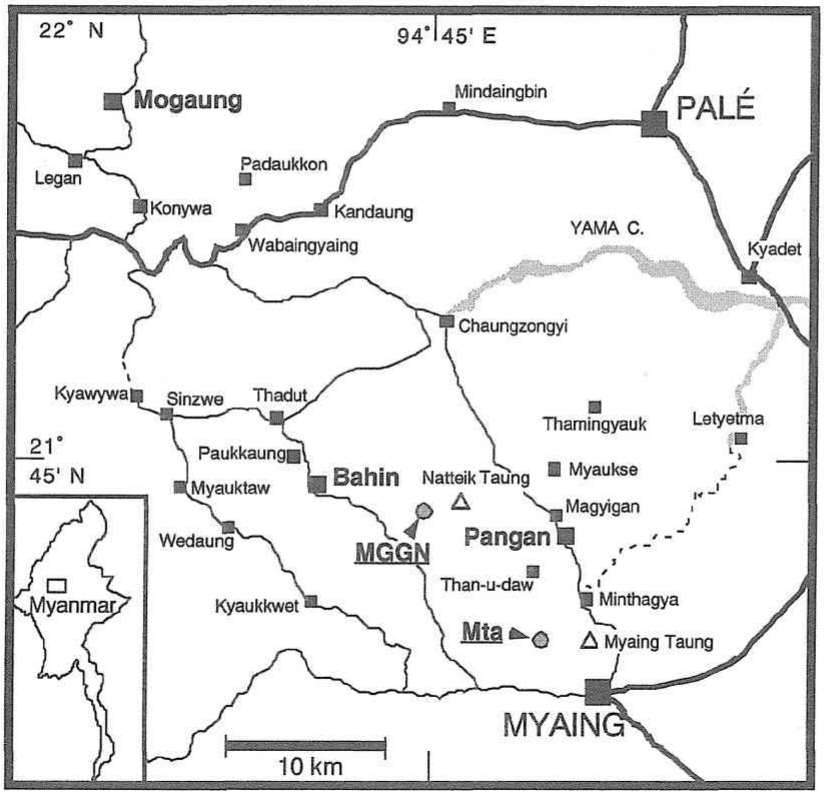

Figure 4. Local topographic map of Pondaung Area in Myaing and Palé Township, central Myanmar, showing some fossil localities (after Aye Ko Aung, 1999).

November 1998.

1-4. Bh4 (GPS data: N 21° 43' 38.9", E 94° 38' 30.3") (Figure 5): We visited this site on 7 and 11 November 1998, and 13 November 1999.

1-5. Bh5 (GPS data: not available) (Figure 5): We visited this site on 13 November 1999.

1-6. Pk1 (GPS data: N 21° 45' 08.4", E 94° 38' 11.2") (Figure 5): This locality is also called "Humerus Site". Tuffaceous horizon were found here. We visited this site on 8 November 1998, and 14 November 1999.

1-7. Pk2 (GPS data: N 21° 45' 15.8", E 94° 39' 13.5") (Figure 5): Many fossils were found. We visited this site on 9 November 1998, and 15, 16 and 17 November 1999.

1-8. Pk3 (GPS data: N 21° 45' 15.8", E 94° 39' 21.0") (Figure 5): We visited this site on 9 November 1998, and 16 November 1999.

1-9. Pk4 (GPS data: N 21° 45' 10.3", E 94° 38' 50.2") (Figure 5): We visited this site on 10 November 1998.

1-10. Pk5 (GPS data: N 21° 45' 23.6", E 94° 38' 22.2") (Figure 5): We visited this site on 10 November 1998.

1-11. Pk6 (GPS data: not available) (Figure 5): We visited this site on 14 November 1999.

1-12. Pk7 (GPS data: not available) (Figure 5): We visited this site on 14 November 1999.

2. Pangan area (Figures 1, 4, 6)

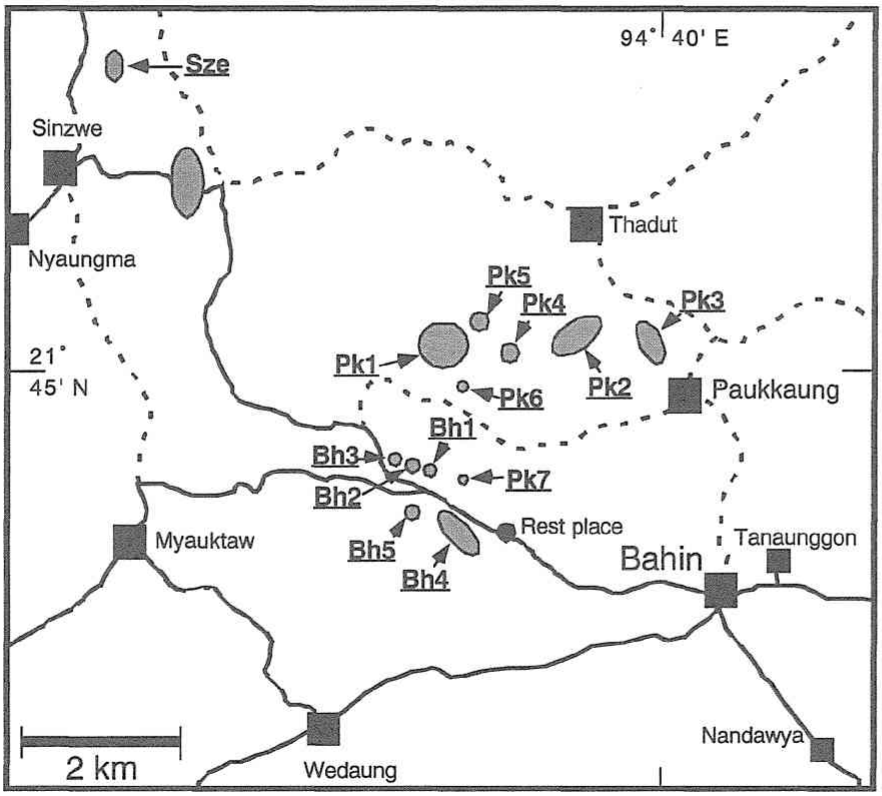

Figure 5. Detailed local topographic map of Bahin area in Myaing Township, central Myanmar (after Pondaung Fossil Expedition Team, 1997).

Pangan area is located about ~ 20 km north from Myaing. The base camp for the expedition was settled at Magyigan Village (GPS data: N 21° 43' 17.1", E 94° 48' 46.7").

2-1. PGN1 (GPS data: N 21° 42' 47.6", E 94° 49' 16.3") (Figure 6): This locality is located on the west site of the road from Pangan Village to Magyigan Village. We visited this site on 12, 13 and 15 November 1998, and 19 November 1999.

2-2. PGN2 (GPS data: N 21° 42' 31.6", E 94° 48' 45.6") (Figure 6): This locality is located west to Pangan Village, and is also called Taungni Kyitchaung. We visited this site on 14 and 15 November 1998, and 20 November 1999.

2-3. Tmk (GPS data: N 21° 45' 28.7", E 94° 50' 18.3") (Figure 6): This locality is located southwest to Thamingyauk Village. We visited this site on 13 November 1998.

2-4. MGGN (GPS data: N 21° 45' 28.7", E 94° 50' 18.3") (Figure 4): This locality is located near Magyigon Village. We visited this site on 14 November 1998.

2-5. Mta (GPS data: not available) (Figure 4): This locality is located southwest to Minthagya Village. We visited this site on 19 and 21 November 1999.

3. Mogaung area (Figures 1, 4, 7)

Mogaung area is located about 35 ~ 40 km west from Palé. The base camp for the expedition was settled at Mogaung Village (GPS data: N 21° 57' 05.4", E 94° 33' 14.9").

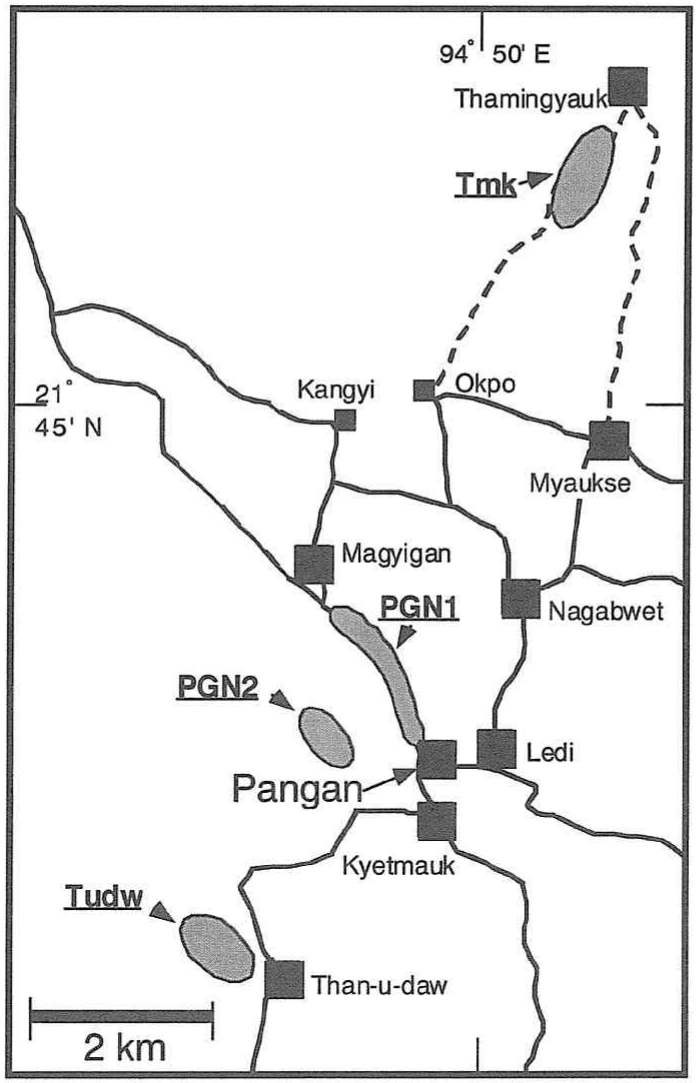

Figure 6. Detailed local topographic map of Pangan area in Myaing Township, central Myanmar, showing fossil localities (after Pondaung Fossil Expedition Team, 1997).

3-1. Lma (GPS data: N 21° 57' 06.7", E 94° 32' 14.4") (Figure 7): This locality is called Lema Kyitchaung. We visited this site on 17 and 19 November 1998, and 6 and 8 November 1999.

3-2. Thdn (GPS data: N 21° 57' 49.6", E 94° 32' 37.2") (Figure 7): This locality is called Thandaung Kyitchaung. We visited this site on 18 November 1998, and 7 and 9 November 1999.

The Pondaung fauna

The previous study on faunal structure among the Pondaung mammals which covered whole mammal species from the Pondaung fauna was achieved by Colbert (1938). Figure 8A shows the mammal faunal list by him. Two genera of Primates, four genera of Artiodactyla, and five genera of Perissodactyla were recognized from the Pondaung Formation by him (Figure 8A). Since Colbert's study in 1938, there have been some studies on the Pondaung primates (e.g. Szalay, 1970, 1972; Simons, 1971; Ba Maw *et al.*, 1979;

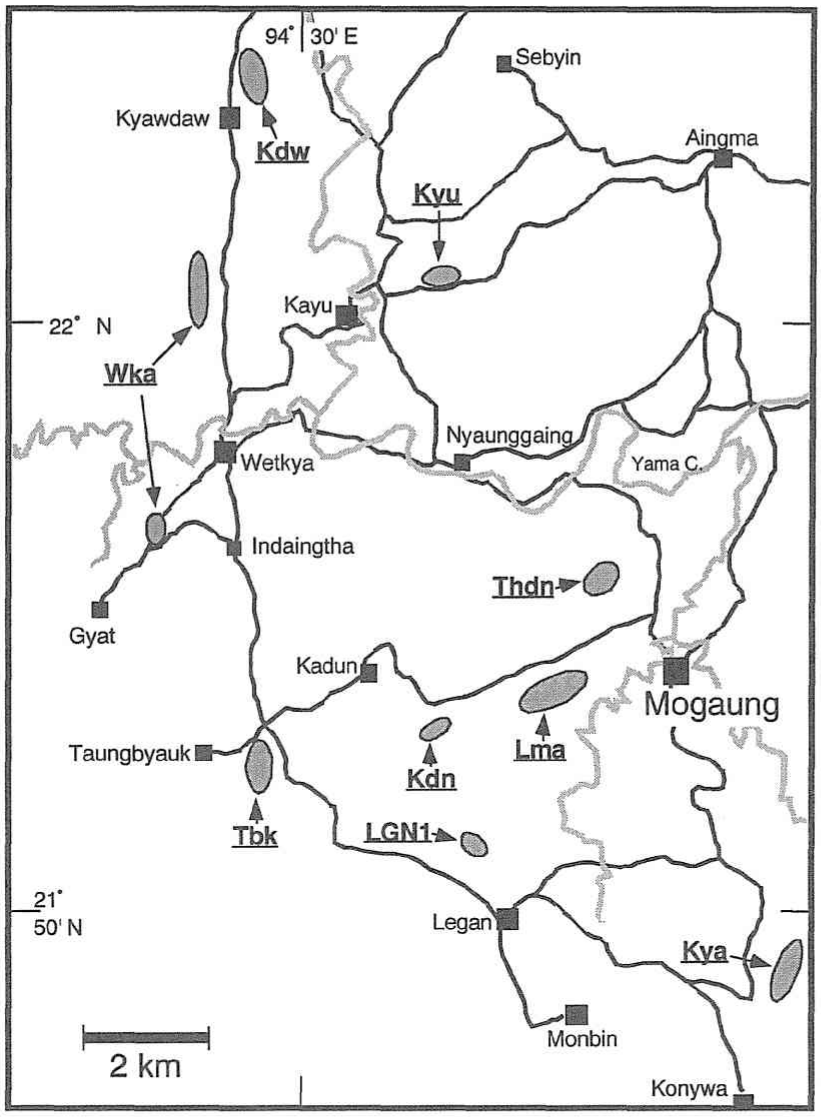

Figure 7. Detailed local topographic map of Mogaung area in Palé Township, central Myanmar, showing fossil localities (after Pondaung Fossil Expedition Team, 1997).

Ciochon *et al.*, 1985; Ciochon and Holroyd, 1994; Jaeger *et al.*, 1998, 1999) and a study on *Pakkokuhyus* (Artiodactyla) (Holroyd and Ciochon, 1995), but there has been no study on the whole Pondaung mammal fauna.

A new Pondaung faunal list revised by this paper is shown in Figures 8C, 9. A preliminary description of the new mammal material from the Pondaung fauna will be presented first; then, biostratigraphic and chronological issues relating to this important Paleogene mammal fauna will be discussed.

Systematic paleontology

Class Mammalia Linnaeus, 1758

Order Primates Linnaeus, 1758

Comments.—Three primate genera have been described so far: *Pondaungia*, *Amphipithecus* and *Bahinia*, (Jaeger *et al.* 1999). Another new primate was found in 1998,

A

Colbert (1938)

Primates
Anthropoidea
Amphipithecus
Pondaungia

Artiodactyla
Anthracotheriidae
Anthracohyus
Anthracothema
Anthracokeryx
?Hypertragulidae
Indomeryx

Perissodactyla
Brontotheriidae
Sivatitanops
?Metatelmatherium
Amynodontidae
Paramynodon
Tapiroidea
Fam. indet. (?Isectolophidae)
Indolophus
Depereteliidae
Deperetella

B

Before this study

Primates
Anthropoidea
Eosimiidae
Bahinia
Amphipithecidae
Amphipithecus
Pondaungia

Artiodactyla
Anthracotheriidae
Anthracohyus
Anthracothema
Anthracokeryx
?Hypertragulidae
Indomeryx
Helohyidae
Pakkokuhyus

Perissodactyla
Brontotheriidae
Sivatitanops
?Metatelmatherium
Amynodontidae
Paramynodon
Tapiroidea
Fam. indet. (?Isectolophidae)
Indolophus
Depereteliidae
Deperetella (*Diplolophodon*)

C

This Study

Primates
Anthropoidea
Eosimiidae
Bahinia
Amphipithecidae
Amphipithecus
Pondaungia
Fam. nov.
gen. nov.

Creodonta
Hyaenodontidae
indet. A
indet. B

Rodentia
?Phiomyidae
indet. C

Ungulata
Order *et* fam. indet.
indet. D

Artiodactyla
?Agriochoeridae
indet. E
cf. indet. E
Anthracotheriidae
Anthracohyus
Anthracothema
Anthracokeryx
Helohyidae
Pakkokuhyus
Ruminantia
?"Gelocidae"
Indomeryx
cf. *Indomeryx*

Perissodactyla
Brontotheriidae
Sivatitanops
?Metatelmatherium
Rhinocerotoidea
?Rhinocerotidae
cf. *Ilianodon*
Amynodontidae
Paramynodon
indet. F
Tapiroidea
Fam. indet.
Indolophus
Depereteliidae
Deperetella

Figure 8. Faunal list of the Pondaung fauna above the species level. **A**, the faunal list by Colbert (1938). **B**, the faunal list before this study (after Colbert 1938; Holroyd and Ciochon, 1995; Jaeger *et al.*, 1998, 1999). **C**, the faunal list of this study.

and referred as a new genus and species in the faunal list. Therefore, we recognize four primate genera from the Pondaung Formation. See Takai *et al.* (in this volume) for more detailed information on the Pondaung primates.

Order Creodonta Cope, 1875

Comments.—Two types of hyaenodontid creodont (indet. A and indet. B) were found. See Egi & Tsubamoto (in this volume) for more detailed information on the creodonts.

Order Rodentia Bowdich, 1821

Family ?Phiomyidae Wood, 1955

?Phiomyidae indet. C (Plate 1)

Material.—NMMP-KU 0047, a left $M_{2?}$; NMMP-KU 0048, a right maxillary fragment with P^{3-4}; NMMP-KU 0049, a left mandibular fragment with M_{2-3}?; NMMP-KU 0213, a left mandibular fragment with M_{1-3}; NMMP-KU 0231, a right mandibular fragment with M_{1-3}.

Localities.-- NMMP-KU 0047-0049 were from Wka or Kdw (Figure 7); NMMP-KU

0213 was from Bh1 (Figure 5); NMMP-KU 0231 was from Pk2 (Figure 5).

Comments.—These dental material have brachyodont teeth. The dental structure is similar to that of phiomyids, but further comparison is needed to identify systematic position of these material.

Paleogene phiomyids were found only from Africa and West Asia (McKenna and Bell, 1997). If these material are true phiomyids, this will be the first record of phiomyids from southeastern Asia, and will be considered as very interesting material on the origin of the Phiomyidae.

Grandorder Ungulata Linnaeus, 1766

Order *et* family indet.

Ungulata indet. D (Plates 2-4)

Material.—NMMP-KU 0031, a right upper jaw fragment with M^{2-3}; NMMP-KU 0032, a left mandibular fragment with M_3; NMMP-KU 0033, a right mandibular fragment with M_2; NMMP-KU 0034, talonid part of a left M_3; NMMP-KU 0035, a right upper jaw fragment with M^{1-3}; NMMP-KU 0036, a left mandibular fragment with P_4M_{1-3}; NMMP-KU 0037, a right mandibular fragment with dP_4M_{1-2}.

Localities.— NMMP-KU 0033, 0034 and 0037 were from Bh1 (Figure 5); NMMP-KU 0031, 0032, 0035 and 0036 were from Bahin area (Figures 1, 5).

Diagnosis.—This form is a small ungulate mammal. Upper molars have: large paracone, metacone and protocone, tiny paraconule and metaconule, hypocone and pericone which are roughly same size, distinct parastyle and mesostyle which the former is larger than the latter. Metastyle is absent. P_4 is premolariform and simple. Lower molar has protoconid, metaconid, hypoconid and hypoconulid. Paraconid is absent. Trigonid is widely open mesiolingually, making comparatively large trigonid basin and very wide trigonid angle. Preprotocristid runs down mesially, and then turns distolingually, and finally runs up distally to the tip of metaconid. Metaconid is located pretty distally to protoconid. A cristid linking hypoconid directly to entoconid exists. Hypoconulid basin is also recognized not only on M_3 but also on M_{1-2}: the area surrounded by hypoconulid, posthypocristid, hypoconid, the cristid linking hypoconid directly to entoconid, and entoconid. Molar sizes increase gradually from M^1/M_1 to M^3/M_3.

Remarks.—Three types are preliminary identified: type 1 = NMMP-KU 0031, 0033 and 0037; type 2 = NMMP-KU 0035 and 0036; type 3 = NMMP-KU 0032 and ?0034.

Diagnosis for type 1.—Mesostyle is large, and parastyle is very large. Both of them are larger than those in type 2, respectively. Hypocone is slightly larger than in type 2. Hypoconulid is larger than that in type 2. Mandible of type 1 is as deep as that of type 2, and is shallower and more gracile than that of type 3.

Primates
Anthropoidea
Eosimiidae
Bahinia pondaungensis
Amphipithecidae
Amphipithecus mogaungensis
Pondaungia cotteri
(*Pondaungia minuta*)
Fam. nov.
Gen. et sp. nov.

Creodonta
Hyaenodontidae
indet. A
indet. B

Rodentia
?Phiomyidae
indet. (two species ?)

Ungulata
Order et family indet.
gen et sp. nov.

Artiodactyla
?Agriochoeridae
gen et sp. nov.
cf. gen et sp. nov.
Suiformes
Anthracotheriidae
Anthracohyus choeroides
Anthracothma pangan
Anthracothma rubricae
(Anthracothma crassum)
(*Anthracothma plaustre*)
Anthracokeryx birmanicus
Anthracokeryx tenuis
Anthracokeryx moriturus
(*Anthracokeryx hospes*)
(*Anthracokeryx myaingensis*)
(*Anthracokeryx bumbusae*)
(*Anthracokeryx ulnifer*)

Helohyidae
Pakkokuhyus lahirii
Ruminantia
? "Gelocidae" (?Leptomerycidae)
Indomeryx cotteri
(*Indomeryx arenae*)
cf. *Indomeryx cotteri*

Perissodactyla
Brontotheriidae
Sivatitanops cotteri
Sivatitanops birmanicum
Sivatitanops (?) *rugosidens*
Metatelmatherium (?) *browni*
Metatelmatherium (?) *lahirii*
Rhinocerotoidea
?Rhinocerotidae
cf. *Ilianodon lunanensis*
Amynodontidae
Paramynodon birmanicus
(*Paramynodon cotteri*)
indet.
Tapiroidea
Fam. indet.
Indolophus guptai
Deperetellidae
Deperetella birmanicum

Figure 9. Faunal list of the Pondaung fauna at the species level.

Description of type 1.—On upper molars (M^{2-3}), paracone is larger than metacone. Preparacrista runs down mesially, linking to parastyle. Postparacrista runs down distally. Premetacrista runs down mesially and connects to postparacrista. Postmetacrista runs down distally, linking to cingulum. Preprotocrista runs mesiobuccally, linking to tiny paraconule. Postprotocrista runs distobuccally, linking to tiny metaconule. These form a straight centrocrista in occlusal view. Preparaconulecrista runs toward parastyle, disappearing at mesiolingual base of paraconid. Postparaconulecrista, Pre- and postmetaconulecrista are very weak or absent. Very large parastyle has prominent mesiobuccal lobe. Large mesostyle, which is smaller than parastyle, has also swelled buccal lobe. Hypocone is on the distal cingulum, and is located distal to the tip of protocone. Hypocone is smaller than para-, meta- and protocone, and is larger than para- and metaconule. Pericone, which is slightly

smaller than hypocone, exists on the mesial cingulum, mesial to the tip of protocone. Cingulum is almost continuous except for the lingual to the protocone, surrounding the crown, and bears parastyle, mesostyle, hypocone and pericone. $M^2 < M^3$.

On lower molars, paraconid is absent. Preprotocristid runs down mesially, and then turns distolingually, and finally runs up distally to the tip of metaconid. Therefore, trigonid is widely open mesiolingually, making relatively large trigonid basin and very wide trigonid angle. Metaconid is distal to protoconid. Posterior trigonid wall is vertically diagonal, and diagonal to mandibular extension. Hypoconid has three cristid: prehypocristid (cristid obliqua) runs mesiolingually, linking to trigonid wall below the notch between protoconid and metaconid; posthypocristid runs distolingually, connecting hypoconid with hypoconulid; another cristid runs lingually, linking hypoconid and entoconid directly. There is no cristid that links hypoconulid and entoconid directly. Entoconid locates distal to hypoconid. Preentocristid runs mesially and links entoconid and metaconid, making talonid notch. Postentocristid is very weak or absent. Lingual cingulum is absent. Precingulid exists and originates at the mesial base of metaconid, disappearing at the mesiobuccal base of protoconid. Buccal cingulum exists between protoconid and hypoconid. Postcingulid exists, bearing hypoconulid, on M_2. Hypoconulid basin is recognized on M_2; the area surrounded by hypoconulid, posthypocristid, hypoconid, the cristid linking hypoconid directly to entoconid, and entoconid. The talonid part of M_1 of NMMP-KU 0037 is broken away. $M_1 < M_2$.

DP_4 has trigonid and talonid, both of which morphologies are similar to the molars, and has anteriorly elongated precingulid which is as large as its trigonid.

Diagnosis for type 2.—Molar size is about equal to that of type 1. Parastyle and mesostyle are distinct but smaller than those of type 1. Hypocone is slightly smaller than that of type 1. Hypoconulid and hypoconulid basin smaller than of type 1. Mandible is as deep as that in type 1, and shallower and more gracile than that in type 3.

Description of type 2.—The dental morphology and size is almost identical to the description of the type 1, and the differences are mentioned above in the diagnosis of type 2. Upper and lower first molars are smaller in size than upper and lower second ones, respectively. In upper and lower dentitions, the morphology of first molars are almost identical to the second ones. Prepara- and premetacrista are stronger on M^3, become weaker gradually from M^3 to M^1. These distinct cristae cannot be observed on M^1. Molar sizes increase gradually from M^1/M_1 to M^3/M_3. The size of hypoconulid basin increase from M_1 to M_3. Hypoconulid on M_3 is smaller than in type 3.

P_4 is premolariform, and has large centrally-placed protoconid and a distal cusp. Preprotocrista runs down mesially. Postprotocrista runs down distally, linking to a distal cusp. A weak and continuous cingulum surrounds the tooth crown except for lingual to

protoconid.

Diagnosis for type 3.--Larger than type 1 and type 2. Mandible is deeper and more robust than those of type 1 and 2. Hypoconulid on M_3 is larger than those of type 2.

Description of type 3.—Postcingulid distal to hypoconulid on M_3 is absent. On M_3, hypoconulid is larger than in type 2, and elongates distally, bearing single cusp and hypoconulid basin. Mandible is larger, deeper and more robust than those of type 1 and 2. NMMP-KU 0034, talonid part of a left M_3, is referable to NMMP-KU 0032, a left mandibular fragment with M_3. might be perhaps referred to type 1.

Comments.—In Ungulata indet. D, the upper molar structure is particularly characterized by having pericone as large as hypocone. This pericone occludes to trigonid basin on the lower molar. Because of this relationship, the talonid of all lower molars (M_{1-3}) are divided into two regions: 1) talonid basin, which is surrounded by posterior trigonid wall, cristid obliqua, hypoconid, cristid linking hypoconid and entoconid, entoconid and preentocristid; 2) hypoconulid basin, which is surrounded by entoconid, cristid linking hypoconid and entoconid, hypoconid, posthypocristid and hypoconulid. Protocone occludes to talonid basin, while hypocone occludes to hypoconulid basin. These features distinguish this new genus from any other primitive ungulates.

Large pericone exists in some periptychids such as *Ectoconus* and *Periptychus*. But, the talonids on M_{1-2} of periptychids do not have hypoconulid basin like Ungulata indet. D. Ungulata indet. D does not have lingually expanded protocone base, which is a diagnosis of the Periptychidae. So, it is not referred to the Periptychidae.

The trigonid structure in Ungulata indet. D includes absence of paraconid, wide trigonid angle, large and mesiolingually opened trigonid, and distally located metaconid to protoconid. Based on these morphologies, it is referable to that of primitive perissodactyl like *Hyracotherium* and *Orientolophus*, hyopsodontid "condylarth" *Hyopsodus*, mioclaenid "condylarth" *Pleuraspidotherium* and so on. This trigonid structure is not referable to that of primitive artiodactyls which have distinct paraconid and narrow trigonid angle.

The systematic position of Ungulata indet. D is uncertain. It may be necessary to establish a new family for it.

Order Artiodactyla Owen, 1848

Family Helohyidae Marsh, 1877

Genus ***Pakkokuhyus*** Holroyd and Ciochon, 1995

Pakkokuhyus lahirii (Pilgrim, 1928) Holroyd and Ciochon, 1995 (Plate 5)

Holotype.— GSI B-766, right mandibular fragment with M_{1-3}.

New material.—NMMP-KU 0038, a right mandibular fragment with M_{2-3}; NMMP-KU 0039, a right maxillary fragment with M^{2-3}.

Localities of the new material.—NMMP-KU 0038 was from Bahin area (Figures 1, 5); NMMP-KU 0039 was from Kdw (Figure 7).

Diagnosis.—We follow Holroyd and Ciochon (1995): "Differs from the helohyid genera *Gobiohyus* from the Mongolian middle Eocene and *Helohyus* from the early middle Eocene (Bridgerian) of North America in having: molar paraconids apparently lacking; a continuous labial cingulid on M_3; a basally inflated crown; more bunodont and less conical cusps; stronger labial cingulids on M_1-M_2; less pronounced ectoflexid; absolutely and relatively greater mandibular depth; shorter and less distinct hypoconulid loop on M_3. Further differs from *Gobiohyus* in having relatively higher crowns and from *Helohyus* in having a stronger hypoconulid on the distal cingulid and in lacking cuspulids on the hypoconulid loop. Differs from the possible raoellid *Haqueina* in having: a stronger hypoconulid on the distal cingulid; a weaker and less constricted hypoconulid "loop"; a single M_3 hypoconulid; postcristid lacking; and weaker hypolophid and cristid obliqua. Differs from anthracotheriids in its smaller size and in having a straight hypolophid; a short M_3 hypoconulid loop; and in lacking a premetacristid. Differs from all of the above in having entoconid slightly posterior to hypoconid".

Description.—NMMP-KU 0038, a right mandibular fragment with M_{2-3} is only slightly smaller than GSI B-766, the type of *Pakkokuhyus lahirii*, but the morphology is completely identical to the type specimen.

In NMMP-KU 0039 (a right maxillary fragment with M^{2-3}), the cusps of the upper molars, that is, paracone, metacone, protocone, metaconule and paraconule, are very conical. Development of the cristae are weak. Stylar cusps are absent. A cingulum originates at distolingual base of metaconule and runs buccally. It is continuous to the mesial margin of the crown through the buccal margin, disappearing at the mesiolingual base of protocone. Lingual cingulum exists only between protocone and metaconule. Preparacrista is absent. Postparacrista runs down distally. Premetacrista extends mesially to postparacrista. Postmetacrista runs down distally and connects to the distal cingulum. Premetaconulecrista runs mesiobuccally toward the vally between paracone and metacone. Postmetaconulecrista runs distobuccally, linking to distal cingulum. Cristae linking to protocone and paraconule are unrecognizable because of the wear in the specimen. M^2 and M^3 are nearly same size. Metacone is located more lingually, and metaconule is located more buccally on M^3 than those on M^2. Metaconule of M^3 is relatively lager than that in *Helohyus*.

Discussion.—The reason why NMMP-KU 0039, a right maxillary fragment with M^{2-3}, is referred to *Pakkokuhyus lahirii* are: 1) it has conical, bunodont and brachyodont molars, like lower molars of *P. lahirii*, 2) the sizes of M^2 and M^3 just fit to that of M_2 and M_3 of GSI B-766, the type of *P. lahirii*, and 3) the dental morphology is similar to the upper molar morphology of helohyid *Helohyus*. This is the first discovery of upper dentition for

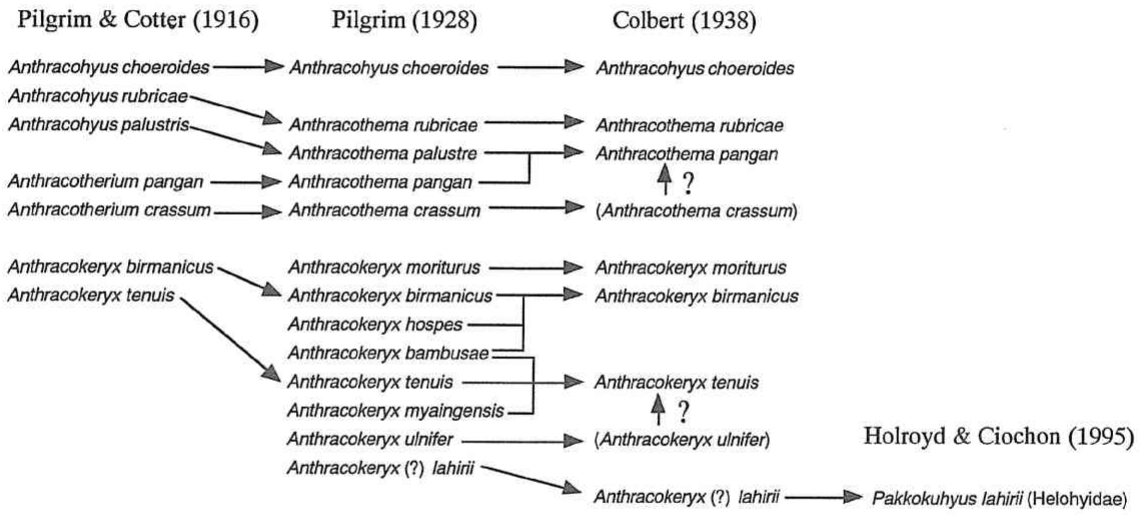

Figure 10. The classifications used in some studies for the Pondaung anthracotheres.

P. lahirii.

Helohyids have been sometimes compared to raoellids. Holroyd and Ciochon (1995) mentioned that *Pakkokuhyus* resembles the putative raoellid, *Haqueina*. However, raoellids have distinct cristae linking paracone-paraconule-protocone, paracone-metacone, and metacone-metaconule. In the lower molar, raoellids have rather distinct cristid connecting hypoconid and entoconid. Protoconid and metaconid are closely situated to each other than those in raoellids. These characters resulted in bilophodont structures of the molars, and the dental morphology have some resemblances to those of tapiroid perissodactyls at those points. Helohyids do not show such bilophodont structures but have conical and bunodont cusps. Raoellids have sharp and premolariform last premolars, while helohyids have molariform or semimolariform last premolars with distinct metacone and paracone, and shallow but distinct talonid basin. Hypoconulid on M_3 is larger in the Helohyidae than in the Raoellidae. So, raoellids is separable from helohyids. In the Raoellidae, *Haqueina* has relatively large hypoconulid on M_3, like helohyids. Homacodonts have hypocone on M^{1-2}, while helohyids do not show any trace of hypocone on M^{1-2}. Anthracotheres have premolariform P_4 like raoellids do.

In the Helohyidae, *Pakkokuhyus* have a progressive structure that there is no trace of paraconid. The upper molar cusps in *Pakkokuhyus* is as conical as those in *Helohyus*. Upper molars of *Gobiohyus* have more distinct cristae and show slightly selenodonty.

Family Anthracotheriidae Leidy, 1869 (Plates 6-8)

Comments.—In the Pondaung mammalian fauna, anthracotheres are most dominantly collected from the field. About 60 - 70% of all identifiable dental material collected in

1998 were referred to anthracotheres. This situation resembles the Krabi fauna of Thailand, where about 80% of the mammal dental material have been attributed to anthracotheres (Ducrocq *et al.*, 1992).

The classification of the Pondaung anthracotheres has been problematic (Figure 10). Pilgrim and Cotter (1916) firstly described the Pondaung anthracotheres and made seven species in three genus, *Anthracohyus*, *Anthracotherium* and *Anthracokeryx*, (Figure 10). Pilgrim (1928) described new material and revised the classification. He recognized three genera (*Anthracohyus*, *Anthracothema* and *Anthracokeryx*) and 13 species among the Pondaung anthracotheres (Figure 10). Colbert (1938) reviewed the Pondaung anthracotheres and considered three genus (same as by Pilgrim, 1928) and seven to nine species (Figure 10). Holroyd and Ciochon (1995) redescribed *Anthracokeryx*? *lahirii* and renamed it *Pakkokuhyus lahirii*, referring it to the Helohyidae. Holroyd and Ciochon (1991) considered that the differences between *Anthracothema pangan* and *Anthracothema crassum*, and those between *Anthracokeryx birmanicus* and *Anthracokeryx tenuis* were due to sexual dimorphism. Ducrocq (1999) synonymized genus *Anthracothema* to *Anthracotherium*.

The reason for such taxonomic confusions is high degree of morphological and size variation among the Pondaung anthracotheres, as is usual in many other anthracotheres. The abundance of such primitive anthracotheres in the Pondaung Formation, in Krabi basin of Thailand, and also in the Naduo and Heti formations of China support the hypothesis that anthracotheres originated in Asia (Suteethorn *et al.*, 1988; Ducrocq, 1994), or at least, support the fact that such primitive anthracotheres were widely spread in Southeastern Asia at that time.

Family ?Agriochoeridae Leidy, 1869

?Agriochoeridae indet. E (Plates 9, 10A-C)

Material.—NMMP-KU 0026, a right $M^{3?}$; NMMP-KU 0027, a right mandibular fragment with M_{2-3}; NMMP-KU 0028, a right mandibular fragment with M_3; NMMP-KU 0029, a right mandibular fragment with M_{1-2}; NMMP-KU 0068, a right mandibular fragment with M_3; NMMP-KU 0264, a left mandibular fragment with M_{2-3}.

Localities.— NMMP-KU 0026 and 0068 were from Bh1 (Figure 5); NMMP-KU 0027 was from Bahin area (Figures 1, 5); NMMP-KU 0028 and 0029 were from Mogaung area (Figures 1, 7); NMMP-KU 0264 was from Mta (Figure 4).

Diagnosis.—This form is a small and primitive agriochoerid-like mammal. Size and dental morphology resemble those of *Protoreodon parvus*. Tooth enamel is slightly wrinkled. Selenodonty in upper molar is weaker than that in *P. parvus*. Paraconule is relatively large. Lingual margin of metaconule is far more buccal to that of protocone than that in the other agriochoerids such as *Agriochoerus* and *Protoreodon*. Neither metastylid

nor entostylid exists on the lower molar. Entoconid is somewhat transversely compressed. Metaconid is more conical than entoconid.

Description.—The only upper molar material, NMMP-KU 0026, has paracone, metacone, protocone, metaconule, paraconule and parastyle. Parastyle are small, but distinct. Paraconule is larger and parastyle is weaker than those in *Protoreodon parvus*. Paracone has strong buccal ridge. Preparacrista links to parastyle. Postparacrista connects to premetacrista at the mesostylar region, making a ridge at mesostylar region. Postmetacrista runs to metastylar region, making slight bulge at metastylar region. Preparaconulecrista runs and links to parastyle. Postparaconulecrista is very weak. Preprotocrista runs to paraconule and hits just buccal to paraconule. Postprotocrista runs toward metaconule and hits mesial wall of metaconule. Premetaconulecrista runs toward mesostylar region, disappearing between paracone and metacone. Postmetaconulecrista runs toward metastylar region and meets the bulge at metastylar region. A cingulum that originates below mesiolingual base of parastyle is continuous through mesial and lingual face of the tooth, disappearing at the distal base of metaconule. No cingulum exists at the buccal side to metaconid. A crista from the tip of parastyle runs steeply down distally, disappearing at the buccal to the buccal ridge of the paracone. Lingual margin of metaconule is far more buccal to that of protocone in this form than in the other agriochoerids such as *Agriochoerus* and *Protoreodon*.

Outer cusps of lower molars are selenodont. Entoconid is somewhat transversely compressed. Metaconid is rather conical. Paraconid is absent. Hypoconulid is very small on $M_{1\text{-}2}$, and is large and distally elongated on M_3. Lingual cingulum is absent. Precingulid runs from the mesial base of metaconid, disappearing at the mesiobuccal base of protoconid. Buccal cingulum exists between protoconid and metaconid. Postcingulid runs from the distolingual base of entoconid and disappears at the distal base of hypoconid on $M_{1\text{-}2}$, bearing small hypoconulid. There is no postcingulid on M_3. Postprotocristid runs down lingually and then runs up to the tip of metaconid, making a V-shaped notch between protoconid and metaconid on the posterior trigonid wall. Preprotocristid links to the mesiobuccal base of metaconid. Premetacristid runs down mesially and connects to preprotocrista. Postmetacristid runs down distally. Neither metastylid nor entostylid exist. Prehypocristid (cristid obliqua) meets trigonid wall below the notch between protoconid and metaconid. Posthypocristid runs lingually and turns distolingually at the distobuccal base of entoconid, linking to hypoconulid. Postentocristid runs down distally and doesn't connect to any other cristid. Preentocristid runs down mesially and meets postmetacristid, making V-shaped notch. There is no ectostylid. Hypoflexid is deep. On M_3, hypoconulid is large and posteriorly elongated, and bears single cusp and single hypoconulid loop. The inner ridge of hypoconulid loop stops at postentoconulid region, making crenulation there,

and its outer ridge connects to posthypocristid. Molar size increase gradually from M_1 to M_3.

Mandible is as deep as that of *Protoreodon parvus* but somewhat more robust. Teeth have slightly wrinkled enamel.

Comparisons.—NMMP-KU 0026, a right $M^{3?}$, is characterized by its relatively small size, the selenodont structure with small but distinct paraconule, with hypertrophied metaconule, and without hypocone. All these characters compare well with the characteristics of the upper molar of primitive agriochoerids (protoreodonines) known only from North America. Though some helohyids and anthracotheres have similarity to NMMP-KU 0026, helohyids have more conically-shaped shaped cusps, and anthracotheres are much larger. Even small and primitive anthracotheres such as *Siamotherium* are still larger and have more conical cusps than NMMP-KU 0026. Within the Agriochoeridae, NMMP-KU 0026 resemble to *Protoreodon parvus* (Protoreodontinae) in size and dental morphology. Lander (1998) reported the existence of four new genera for the Protoreodontinae, but we cannot compare NMMP-KU 0026 with these new genus because they have not been described yet. *P. parvus* is a primitive agriochoerid. Compared to *P. parvus*, which is a primitive agriochoerid, NMMP-KU 0026 has: larger paraconule; taller, conical and erect paracone and metacone; weaker parastyle; less inflated mesostyle; and molars with lesser degree of selenodonty. These are primitive characteristics for the Agriochoeridae.

The lower dental material, NMMP-KU 0027-0029, 0068, 0264, are referred to the same species as NMMP-KU 0026 because the dental morphology is similar to *Protoreodon parvus*, and the sizes are nearly fit to NMMP-KU 0026 (the upper molar). However, these material do not have metastylid, which is typical in agriochoerids. This lower dental characteristics also suggests that ?Agriochoeridae indet. E is more primitive than *P. parvus*.

Atopotherium (Ducrocq *et al.*, 1996) from the Eocene deposit of Krabi, Thailand has some resemblances to ?Agriochoeridae indet. E in the morphology of lower molars, but *Atopotherium* is much larger, and has much deeper mandibular ramus and more mesiodistally-compressed trigonid and talonid than ?Agriochoeridae indet. E does. Ducrocq *et al.* (1996) noticed the similarity between *Atopotherium* and agriochoerids, but they referred it to the Anthracotheriidae, judged from the lower premolar morphology (no upper dentition of *Atopotherium* has not been discovered). Because no premolar dentition of ?Agriochoeridae indet. E has been discovered, we cannot compare it with *Atopotherium* more precisely.

Comments.—The Agriochoeridae have never been found from outside of North America so far. However, according to Ducrocq *et al.* (1996), Viret (1961) supposed that oreodonts (including agriochoerids) originated in Asia. The discovery of this possible agriochoerid, ?Agriochoeridae indet. E, in Myanmar, a part of Asia, supports this idea.

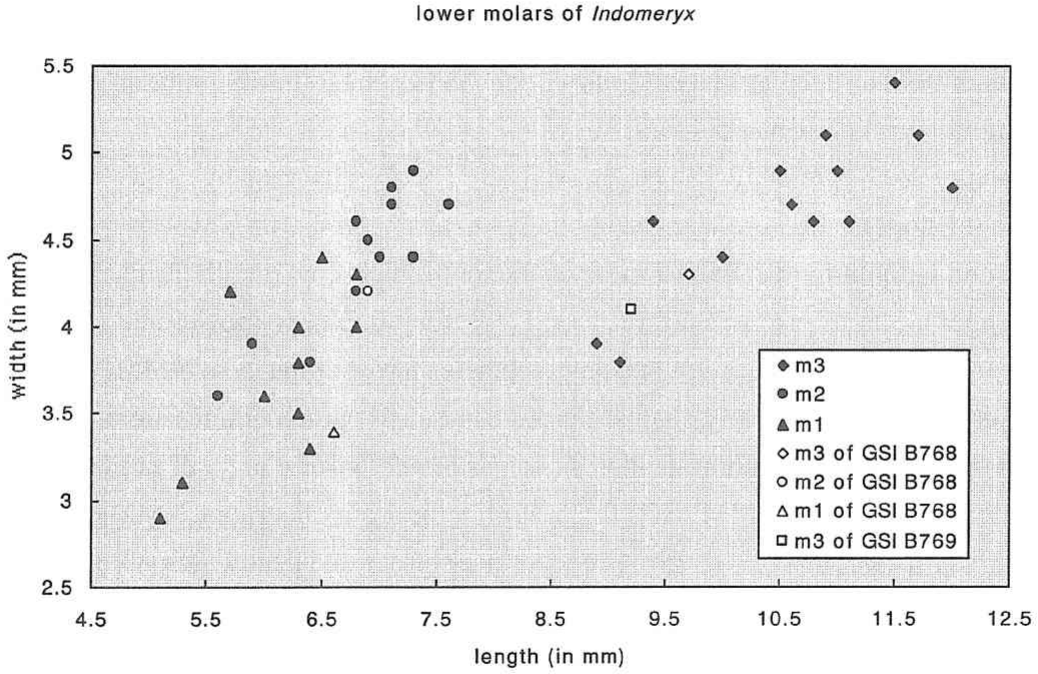

Figure 11. Size distribution of lower molars in *Indomeryx* from the Pondaung Formation and the Naduo Formation.

However, ?Agriochoeridae indet. E itself may not be closely related to ancestors of other agriochoerids, because the earliest agriochoerid (*Protoreodon*) had already appeared in late Bridgerian (early middle Eocene) in North America (Lander, 1998, fig. 27.6), while the age of the Pondaung Formation is considered to be middle middle to late Eocene (see Geological setting and Mammal biostratigraphy).

Cf. ?Agriochoeridae indet. E (Plate 10D-F)

Material.—NMMP-KU 0030, a right mandibular fragment with $M_{1 \text{ or } 2}$.

Locality.—Mogaung area (Figures 1, 7).

Description.—Size and dental morphology of the preserved molar of NMMP-KU 0030 is nearly identical to that of M_1 of ?Agriochoeridae indet. E (NMMP-KU 0029). However, the following features in NMMP-KU 0030 are distinct from those of ?Agriochoeridae indet. E: the mandibular is much more slender than that of ?Agriochoeridae indet. E, and is similar to that of *Indomeryx*; postprotocristid runs down lingually and stops at the distal base of metaconid, while that of ?Agriochoeridae indet. E runs down lingually and then runs up to the tip of metaconid, making a V-shaped notch between protoconid and metaconid.

Comments.— -This material may perhaps belong to other or new mammal species, but we just describe as cf. ?Agriochoeridae indet. E because of the scanty fossil record of this form.

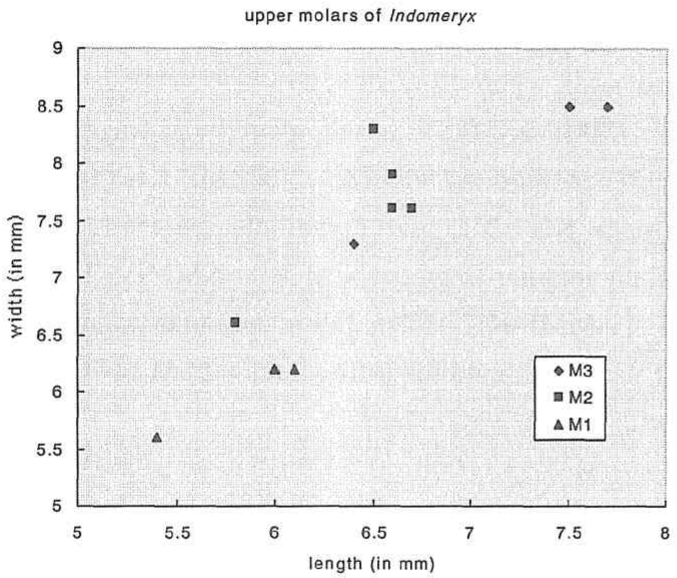

Figure 12. Size distribution of upper molars in *Indomeryx* from the Pondaung Formation and the Naduo Formation.

Suborder Ruminantia Scopoli, 1777

Family ?"Gelocidae" Schlosser, 1886

Genus ***Indomeryx*** Pilgrim, 1928

Type and only species.—Indomeryx cotteri.

Revised diagnosis.—This form is a small and primitive ruminant. Mandible is slender. Teeth are brachyodont. Selenodonty are weaker than in "gelocid" *Notomeryx*. Postprotocrista extends posteriorly toward the anterior metaconule wall and connects to the wall. Almost no outer cingulum exists on the upper molars. Metastylid is absent. No postentoconulid exists on M_3. Preentocristid has distinct double ridge, and the lingual one has a tiny entostylid. Metaconid is conical. Metacristid is hardly identifiable. Entoconid is somewhat buccolingually compressed more than metaconid. Preprotocrista connects to the base of metaconid centrally. Neither *Dorcatherium*-fold nor *Palaeomeyx*-fold exists.

Indomeryx cotteri Pilgrim, 1928 (Plates 11-13, 14A-D)

Synonymy.—I. arenae Pilgrim, 1928.

Holotype.—GSI B768, a right mandibular ramus with P_4-M_3.

New material.—NMMP-KU 0007, a right upper jaw fragment with M^{1-3}; NMMP-KU 0008, a left upper jaw fragment with M^{1-3}; NMMP-KU 0009, a left upper jaw fragment with M^{2-3}; NMMP-KU 0010, a right upper jaw fragment with $dP^{3-4}M^1$ (or dP^4M^{1-2}); NMMP-KU 0011, a left mandibular fragment with P_4M_{1-3}; NMMP-KU 0012, a right mandibular fragment with M_3; NMMP-KU 0013, a right mandibular fragment with P_4M_{1-3}; NMMP-KU 0014, a left mandibular fragment with M_3; NMMP-KU 0015, a left mandibular fragment with M_{1-3}; NMMP-KU 0016, a left mandibular fragment with M_{1-3}; NMMP-

KU 0017, a right mandibular fragment with M_3; NMMP-KU 0018, a left mandibular fragment with M_{2-3}; NMMP-KU 0019, a right mandibular fragment with $P_{3-4}M_{1-3}$; NMMP-KU 0020, a left mandibular fragment around P_3 without any tooth crown; NMMP-KU 0021, a right mandibular fragment with P_4; NMMP-KU 0022, a right mandibular fragment with P_4; NMMP-KU 0024, a right mandibular fragment with $M_{1\text{ or }2}$; NMMP-KU 0050, a left mandibular fragment with M_{2-3}; NMMP-KU 0201, a left mandibular fragment with broken M_{1-3}; NMMP-KU 0222, a right mandibular fragment with M_{2-3}; NMMP-KU 0266, a right mandibular fragment with M_{1-2}; NMMP-KU 0268, a left mandibular fragment with talonid part of M_3; NMMP-KU 0289, a right mandibular fragment with M_3; NMMP-KU 0290, a left mandibular fragment with broken two molar.

Localities of the new material.—NMMP-KU 0007, 0011-0015 were from Bahin area (Figures 1, 5); NMMP-KU 0008, 0009, 0017-0021 were from Mogaung area (Figures 1, 7); NMMP-KU 0010, 0024, 0201 were from Lma (Figure 7); NMMP-KU 0016 was from Bahin or Mogaung area (Figures 1, 5, 7); NMMP-KU 0022 was from Bh4 (Figure 5); NMMP-KU 0050 was from Bh1 (Figure 5); NMMP-KU 0222 was from Pk1 (Figure 5); NMMP-KU 0289, 0290 were from Mta (Figure 4).

Diagnosis.—As for genus.

Description.—Upper molars have four main cusps. Inner cusps are selenodont, and outer cusps are rather conical. Metaconule is hardly reduced on M^3. Small but distinct mesostyle and parastyle exist. Entostyle is absent. Metastyle is absent on M^{1-2}, and is absent or very weakly developed on M^3. Preparacrista and preprotocrista converge into parastyle. Postparacrista and premetacrista converge into mesostyle. Postmetacrista extends posteriorly. Postprotocrista extends posteriorly toward the anterior metaconule wall and connects to the wall. Premetaconulecrista orients toward the mesostyle and stops between paracone and metacone. Postmetaconulecrista runs to metastylar region and connects to postmetacrista. Development of pre-, post-, and lingual cingula are weak as a whole. Precingulum originates from mesiolingual base of protocone, and disappears at its mesiobuccal base. Lingual cingulum exists between protocone and metacone. Precingulum and lingual cingulum are continuous through the buccal side of protocone in some cases. Postcingulum originates distolingual base of metaconule disappears at its distobuccal base. Buccal cingulum is absent or very weakly developed. There are variations in the degree of the development of those cingula.

In NMMP-KU 0010, a left maxillary fragment with three teeth, the most anterior tooth (dP^3) is broken. The tooth have distinct metacone as that in the molars. The proportion of the central tooth (dP^4) is mesiodistally longer relative to the buccolingual width than its next posterior tooth (M^1) and upper molars of the other specimens of *Indomeryx cotteri*. The most posterior tooth preserved in NMMP-KU 0010 (M^1) is unworn and its

morphology is identical to upper molars of the other specimens of *I. cotteri*.

P_3 has two roots. The crown is mesiodistally slender in occlusal view and bears centrally-placed protoconid which has pre- and postprotocristids. Preprotocristid connects to small but distinct paraconid. Morphology of posterior part of P_3 is unidentifiable because P_3 is only known in NMMP-KU 0019, and its preservative condition is not good.

P_4 is larger and wider than P_3, and has centrally-placed protoconid with pre- and postprotocristids. Most anterior part of the preprotocristid bends mesiolingually and joins small but distinct paraconid. Postprotocristid is double ridged. Buccal one runs posteriorly and links to small hypoconid. Lingual one runs mesiolingually, bearing tiny metaconid close and just lingual to the protoconid, and links to hypoconid encircling shallow and small talonid basin. There are individual variations in the cristids' structure of the distal part of P_4. Some other cristids exist in some individuals.

Concerning lower molars, there are four and five main cusps on M_{1-2} and M_3, respectively. Outer cusps are selenodont. Metaconid is conical and entoconid is also conical but somewhat compressed buccolingually more than metaconid. Hypoconulid is small on M_{1-2}, and large and elongated distally on M_3. Paraconid is absent. Neither *Dorcatherium*-fold nor *Palaeomeyx*-fold exists. Lingual cingulum is absent. Precingulid runs from the mesial base of metaconid, disappearing at the buccal base of protoconid. Buccal cingulum exists between protoconid and hypoconid. On M_3, buccal cingulum also exists between hypoconid and hypoconulid. There are individual variation with regard to the development of these cingula. On M_{1-2}, postcingulid runs from the base of postentocristid and disappears at the distal base of hypoconid, bearing small hypoconulid. There is no postcingulid on M_3. Postprotocristid runs mesiolingually, linking to the distal base of metaconid. Preprotocrista runs rather lingually, linking to the mesiobuccal base of metaconid. The point that preprotocrista links to the base of metaconid is centrally placed and more buccal than the point that postprotocristid links to the base of metaconid. Pre- and postmetacristid are not distinct. There is no metastylid, but a faint swelling can be identifiable just distolingual to the metaconid. Prehypocristid (cristid obliqua) runs mesiolingually and meets trigonid wall nearly central position buccolingually. Posthypocristid runs distolingually and stops just distal to the base of entoconid. Pre- and posthypocristid don't connect to any other cristid. Preentocristid has a distinct double ridge: the inner one bears tiny entostylid, and the outer one meets trigonid wall just below the point that postprotocristid links to the base of metaconid. Postentocristid is slightly developed and runs distally, connecting to postcingulid in M_{1-2}, to hypoconulid loop in M_3. Ectostylid is absent. On M_3, hypoconulid is large and is posteriorly elongated, and bears single cusp, single hypoconulid loop, and distinct hypoconulid basin. Inner ridge of hypoconulid loop is continuous to postentocristid, and outer ridge runs anteriorly, meeting the distal wall of

hypoconid. Postentoconulid does not exist on M_3.

Upper and lower molar sizes increase gradually from M^1/M_1 to M^3/M_3. Mandible is as slender as that of *Archaeomeryx* and more slender than that of *Notomeryx*. Unlike *Leptomeryx*, mandible of *Indomeryx* does not show the dorsoventral expansion at the posterior part. Small diastema exists between P_2 and P_3. Mental foramen exists just below the anterior root of P_3.

Remarks.— Previously reported material of this species from the Pondaung Formation (the type formation for *Indomeryx*) are only lower dentitions. This is the first report on the upper dentitions from this formation. Upper and lower dental material of this species have been also reported from the Naduo Formation, Bose (Baise) and Yongle basins, Guangxi, southeastern China (Qiu, 1978; Guo *et al.*, 1999).

Discussion.—Qiu (1978, p. 9, line 13 from the bottom) mentioned that the specimens of *Indomeryx cotteri* described and figured in Colbert (1938, p. 394, fig. 55), AMNH 20023 and 32521, belong to *Notomeryx besensis*. However, the size and dental morphology of AMNH 20023 and 32521 is definitely identical to that of *I. cotteri*.

Pilgrim (1928) described *Indomeryx arenae* based only on a mandibular fragment with the talonid part of M_3 (GSI B769). He distinguished it from *Indomeryx cotteri* by the following features: 1) its smaller size; 2) lesser degree of concavity of the lower border of the ramus behind M_3; 3) absence of buccal cingulum on M_3; and 4) preentocristid showing a double ridge which is absent in *I. cotteri*. Colbert (1938) considered that *I. arenae* is probably synonymous with *I. cotteri*. He mentioned that : 1) the size differences between the specimens were not large enough to separate them into two species; 2) the differences in the shapes of the lower border of the ramus were the differences between the immature material (*I. cotteri*) and the fully adult material (*I. arenae*); 3) the difference in the degree of cingulum development resulted from individual variation; and 4) the preentocristid showing a double ridge was the only difference of *I. arenae* from *I. cotteri*.

The new material give more information about the morphology of *Indomeryx*. The double ridged preentocristid, one of the diagnosis of *Indomeryx arenae* cited by Pilgrim, is seen on $M_{1\text{-}3}$ of all good preserved lower dental material of *Indomeryx*, including also previously described material as *Indomeryx cotteri*. This structure is probably one of the most distinct diagnosis of genus *Indomeryx*. Concerning the cingulum and mandibular ramus of the diagnosis of *I. arenae*, the suggestion by Colbert (1938) (see above) are appropriate. Moreover, there is also individual variation on the degree of concavity of the lower border of the ramus behind M_3. Therefore, there is no distinct morphological differences separating *I. cotteri* and *I. arenae*. With regard to the molar size differences, the material of *Indomeryx* can be classified into two (large and small) groups (Figure 11). GSI B769, which is the only specimen described as *I. arenae* and consists only of M_3, is in-

cluded to small-molar-size group with GSI B768, the type of *I. cotteri*, with regard to M_3. It can be concluded that there is no distinct molar size difference between the holotypes of *I. arenae* and *I. cotteri* (Figure 11). Based on these available evidences, it is reasonable to synonymize *I. arenae* to *I. cotteri* as mentioned by Colbert (1938). However, GSI B768 is included to large-molar-size group with regard to M_1 and M_2 (Figure 11). Except for M_3, there are distinct size separations among the upper and lower molar-size distributions (Figures 11, 12). Such size differences can be interpreted in two ways. One is that it indicates intra-specific variation (sexual dimorphism?), the other is that it indicates inter-specific separation. Taking the lack of distinct morphological difference into consideration, we treat this size difference as intra-specific variation (sexual dimorphism?) in this paper.

The classification and phyletic relationships of primitive ruminant including *Indomeryx* has been complicated, because many homoplasy and multiple parallel evolution occurred at the early stage of ruminant evolution (e.g. Janis and Scott, 1988; Scott and Janis, 1993). The familial position of *Indomeryx* has also many controversies. Pilgrim (1928) firstly described *Indomeryx* and tentatively referred it to the Tragulidae. Colbert (1938) and Qiu (1978) referred it to the Hypertragulidae, while Holroyd and Ciochon (1995) treated it as a representative of the "Gelocidae". Guo *et al.* (1999) described *Indomeryx* from China and referred it to a new family Prodremotheriidae (Pecora; Ruminantia) with *Prodoremotherium*, *Notomeryx* and *Gobiomeryx*. McKenna and Bell (1997) referred *Indomeryx* to the Archaeomerycinae (Leptomerycidae).

Indomeryx shows certain resemblances to *Gelocus* ("Gelocidae") and *Archaeomeryx* (Leptomerycidae; Archaeomerycinae) in size and dental morphology (Pilgrim, 1928; Colbert, 1938). *Indomeryx* was also compared to *Notomeryx* because *Notomeryx* was found from the Naduo Formation, Guangxi, China which is located near the Pondaung Formation geographically and chronologically, and because the Naduo Formation also yields *Indomeryx cotteri*, (Qiu, 1978; Guo *et al.*, 1999).

Because of multiple parallel evolution in dental characters among primitive ruminants as mentioned above, it is very difficult to classify *Indomeryx* to any of known ruminant families, and to analyze the phyletic relationships of *Indomeryx* to other ruminants based on such limited and poor material. Here, *Indomeryx* is tentatively referred to the "Gelocidae", which is considered to be a polyphyletic taxon (Janis, 1987; Janis and Scott, 1987). The dental morphology indicates that *Indomeryx* is one of the most primitive ruminant.

Cf. ***Indomeryx cotteri*** Pilgrim, 1928 (Plate 14E)

Material.—NMMP-KU 0025, a right $M^{2?}$.

Locality.—Mogaung area (Figures 1, 7).

Description.—Size and morphology in NMMP-KU 0025 is nearly identical to that of M^2 of the other specimens of *Indomeryx cotteri*, except that: paracone and metacone are more conical; overall shape is less diagonal and somewhat wider transversely; and distinct buccal cingulum buccal to metacone exists.

Comments.—This material may belong to other or new mammal species, but here we tentatively refer it as cf. *Indomeryx cotteri* because of the scanty fossil record of this form.

Order Perissodactyla Owen, 1848

Family Brontotheriidae Marsh, 1873 (Plates 15, 16)

Comments.—So far, two genus and five species of Pondaung brontotheres have been recognized (Colbert, 1938; Figures 8, 9). Those are: *Sivatitanops cotteri*, *Sivatitanops birmanicum*, *Sivatitanops*? *rugosidens*, *Metatelmatherium*? *browni*, *Metatelmatherium*? *lahirii*. There are many taxonomic problems on these mammals because most of these material are very fragmentary, and because only few studies have been done on Pondaung brontotheres since Colbert (1938).

Sivatitanops birmanicum was previously described as *Telmatherium*? *birmanicum* by Pilgrim and Cotter (1916) based on a few fragmentary dental material. It was referred to *Sivatitanops* (the type species is *Sivatitanops cotteri*) by Pilgrim (1928). Material of *Sivatitanops*? *rugosidens* were too fragmentary to make a new species (Colbert, 1938). Generic identification of *S. birmanicum* was questionable (Colbert, 1938). *Metatelmatherium*? *lahirii* was previously described as *Eotitanotherium*? *lahirii* by Pilgrim (1928). It was questionably referred to genus *Metatelmatherium* by Colbert (1938).

Of the new material, NMMP-KU 0306, a left mandibular fragments with $M_{1\text{-}3}$, may be referred to *Metatelmatherium*? *browni*, because the size and cusp configurations of the M_3 of NMMP-KU 0306 are just fit to AMNH 20008, the M^3 of *Metatelmatherium*? *browni*. The teeth enamel of NMMP-KU 0306 is smooth, similar to that of AMNH 20008.

Superfamily Rhinocerotoidea Gray, 1825

?Rhinocerotidae Gray, 1821

Cf. ***Ilianodon lunanensis*** Chow and Xu, 1961 (Plate 17)

Material.—NMMP-KU 0288, a right M^3.

Locality.—Mta (Figure 4).

Description.—NMMP-KU 0288 is distinctly triangular in occlusal view. Very strong precingulum originates from the distal base of protoconid, running buccally. It disappears mesiolingual base of the parastyle. Lingual, buccal and distal cingula are absent. Parastyle is well developed. A depression separates parastyle and paracone. Metaloph is continuous straight to centrocrista. A very slight postmetacrista runs down distolingually from poste-

rior loph (centrocrista-metaloph) at the point slightly closer to hypocone rather than to paracone on the posterior loph. Protoloph joins ecto-metaloph at an angle of about 30 degrees in occlusal view. The dental size of this material is smallest in the rhinocerotoids from the Pondaung Formation.

Comments.—The triangular shape in occlusal view of NMMP-KU 0288 is typical in rhinocerotoid perissodactyls. In the Rhinocerotoidea, amynodonts have quadrate-shaped M^3 in occlusal view, so that this material should be referred to the Hyracodontidae or Rhinocerotidae. The size and morphology of this material is very similar to that of IVPP V2609.2, a broken right M^3 of *Ilianodon lunanensis*, described and figured by Chow and Xu (1961) (Plate 17). It is recorded from the upper part of the Lumeiyi Formation, Lunan Basin, Yunnan, Southeastern China (Chow and Xu, 1961).

Family Amynodontidae Scott and Osborn, 1883
Subfamily Amynodontinae Scott and Osborn, 1883
Tribe Metamynodontini Kretzoi, 1942
Genus ***Paramynodon*** Matthew, 1929

Paramynodon birmanicus (Pilgrim & Cotter, 1916) Matthew, 1929 (Plates 18, 19)

Holotype.—GSI C316 + C317, a right mandible with $C_1P_{3-4}M_{1-3}$.

Comments.—*Paramynodon* is referred to the Metamynodontini, and exhibits skeletal modifications similar to those of hippopotami, showing characteristics typical in semi-aquatic animals (Wall, 1989). *Paramynodon* is very closely related to *Megalamynodon* from the Duchesnean of North America, and perhaps, these genera may be congeneric (Wall, 1989). Colbert (1938) and Wall (1989) suggested that the difference between *Paramynodon birmanicus* and *Paramynodon cotteri* was due to sexual dimorphism. Actually, there is no great difference in size between them. The morphological differences of canine between them mentioned by Pilgrim (1925) are considered to be invalid (Colbert, 1938). Therefore, it is reasonable to synonymize *P. cotteri* to *P. birmanicus*.

AMNH 20012, which is described as *Paramynodon birmanicus* by Colbert (1938) has much more mesiodistally elongated P^4, according to his figure (Colbert, 1938, p. 324, fig. 27). This condition of AMNH 20012 is rather resemble to that of *Megalamynodon regalis*. On the other hand, GSI C325 is described as P^4 of *Paramynodon birmanicus* by Pilgrim and Cotter, 1916). However, the P^4 morphology of other material of *Paramynodon* are distinct from GSI C325. In GSI C344 and C346, which are definitely referred to *Paramynodon birmanicus*, the P^4 is more mesiodistally compressed than that of GSI C325, and has lingually separated protoloph and metaloph, while that of GSI C325 has lingually continuous protoloph and metaloph.

These morphological differences may suggest to remove AMNH 20012 and GSI C325

from *Paramynodon birmanicus*. However, such differences can be considered as individual variations. For example, in *Megalamynodon regalis*, P^3 of C.M. (Carnegie Museum) 11958 has lingually separated protoloph and metaloph, while that of C.M. 11953 has rather lingually continuous protoloph and metaloph (Scott, 1945, pl. 8, figs. 1-2). In *Triplopus obliquidens* (Hyracodontidae, Rhinocerotoidea), upper premolars have relatively great variation in degree of molarization (see Radinsky, 1967, p. 14, fig. 3).

These problematic material (GSI C325 and AMNH 20012) are tentatively referred to *Paramynodon birmanicus* until other better material are found.

Amynodontidae indet. F (Plate 20)

Material.—NMMP-KU 0281, a right M^3; NMMP-KU 0305, a left upper jaw fragment with $?M^{1\text{-}2}$ (or dP^4M^1 or $dP^{3\text{-}4}?$); GSI C328, a left $M^{2?}$.

Localities.— NMMP-KU 0281 was from PGN1 (Figure 6); NMMP-KU 0305 was from Bahin area (Figures 1, 5).

Description and comments.—In these material, the upper molariform teeth have a pi (π) shaped arrangement of lophs with protoloph and metaloph oblique to ectoloph.

NMMP-KU 0281 have: trapezoid outline in occlusal view; ectoloph which concaves buccally at its middle part, and of which metastylar region is very short; protoloph and metaloph spread lingually to one another. These morphology indicates that it is a M^3 of amynodont. Postcingulum is stronger than that on M^3 of *Paramynodon*. This material is heavily worn. This material is much smaller than that of *Paramynodon birmanicus*, and larger than those of *Sianodon sinensis*.

In NMMP-KU 0305, the two molariform teeth, have straight ectoloph, suggesting that it is those of amynodonts. If the tooth class for these teeth are $M^{1\text{-}2}$, the dental size is referable to that of NMMP-KU 0281. If the these teeth are dP^4M^1, the dental size is referable to that of *Paramynodon*, and this material may be referred to *Paramynodon birmanicus*. If the these teeth are $dP^{3\text{-}4}$, the dental size is larger than that of *Paramynodon*.

GSI C328 was previously described as M^2 of *Paramynodon birmanicus* by Pilgrim and Cotter (1916). However, the size is much smaller than M^2 material of *Paramynodon birmanicus*, and is referable to the posterior tooth in NMMP-KU 0305. The lingual lobes (margins) of protocone and hypocone are more lingually elongated than those of *Paramynodon*. The lingual part is much shorter relative to the buccal part than that in *Paramynodon*. The tooth class was not determined, and could be M^2, M^1, dP^3 or dP^4.

Superfamily Tapiroidea Gray, 1825

Family indet.

Genus ***Indolophus*** Pilgrim, 1925

Indolophus guptai Pilgrim, 1925 (Plate 21)

Holotype.—GSI C347, a left maxilla with $P^{2-4}M^1$.

New material.—NMMP-KU 0040, a left mandibular fragment with $M_{2?}$; NMMP-KU 0041, a right mandibular fragment with a broken P_4; NMMP-KU 0265, a left M^3.

Localities of the new material.—NMMP-KU 0040 was from Bahin area (Figures 1, 5); NMMP-KU 0041 was from Pk2 (Figure 5); NMMP-KU 0265 was from Mta (Figure 4).

Diagnosis.—It is slightly revised from Colbert (1938): upper premolars with subconical paracone and metacone, the former connected to the centrally placed protocone by a transverse crest; anterior and posterior cingula well developed; P^2 with prolonged mesiobuccal angle; upper molar with conical paracone and metacone, connected to the protocone and hypocone by well-developed protoloph and metaloph; anterior and posterior cingula well developed.

Description.—In NMMP-KU 0040, a left mandibular fragment with $M_{2?}$, the $M_{2?}$ has protoconid, metaconid, hypoconid and entoconid. Small hypoconulid exists on the postcingulid. Paraconid is absent. Preprotocristid runs down mesiolingually, making anterior margin of trigonid. Postprotocristid runs lingually, connecting protoconid and metaconid. Trigonid angle is not so obtuse as that in the early tapiroids. Trigonid basin is open lingually. Precingulid runs from the mesial base of trigonid, disappearing at the mesiobuccal base of protoconid. Posterior trigonid wall is perpendicular to the mandibular extension in occlusal view, and diagonal to vertical. Lingual and buccal cingulum are absent. Cristid obliqua originates below the shallow notch between protoconid and metaconid. Posthypocristid runs slightly rather distolingually than protocristid, linking hypoconid and entoconid. Talonid basin is open lingually. Small hypoconulid on the postcingulid links neither to hypoconid nor to entoconid. Mandible is robust.

NMMP-KU 0041, a broken right molariform tooth, is slightly smaller in size than the M_2 of NMMP-KU 0040. Overall morphology of this molariform tooth is almost identical to the M_2 of NMMP-KU 0040, except lacking hypoconulid. These conditions are seen in P_4 of early tapiroids, and the preserved tooth in NMMP-KU 0041 is identified as P_4.

The crown of NMMP-KU 0265, a left M^3 exhibits a trapezoid shape in occlusal view. The anterior part is much wider than the posterior. The external border is slightly more oblique than the internal one relative to the direction of the tooth row. Paracone is large and conical, and is more buccally located than metacone. Metacone is also conical but smaller than paracone. Protocone and hypocone are distinct and slightly conical. There is neither trace of paraconule nor metaconule. Parastyle is well developed. Metastylar region is weakly developed. Centrocrista is straight, lacking any trace of mesostyle. Protoloph runs obliquely from protocone, and joins ectoloph anterior to paracone. Metaloph is shorter

and slightly more oblique than protoloph, and runs obliquely from hypocone to reach the base of metacone at its mesiolingual corner. Precingulum is well developed and runs from parastyle to the anterior base of protocone. Buccal cingulum is absent. Lingual cingulum exists between protocone and hypocone. Distal cingulum exists between metacone and hypocone, bearing metastylar region.

Discussion.—The morphology of these lower molars are referable to primitive tapiroid such as lophialetids and isectolophids. Helaletids and deperetellids can be excluded because they have bilophodont lower molars, unlike these material. The sizes and dental morphology are nearly fit to that of the upper dentition in *Indolophus guptai*, which is the only tapiroid except for helaletids and deperetellids from the Pondaung Formation. That is why we refer these material to *I. guptai*. This is the first discovery of the lower dental material of *I. guptai*. M^3 of *Indolophus* is also firstly reported.

The systematic assignment of *Indolophus* at the family level was uncertain because of its unique morphology of the upper dentition (Pilgrim, 1925; Colbert, 1938; Radinsky, 1965). Pilgrim (1925) referred *Indolophus* to the Tapiridae, while Colbert (1938) referred it to the Isectolophidae. Both of these workers considered that *Indolophus* was closely related to the North American isectolophids such as *Homogalax* and *Isectolophus*. Radinsky (1965) discussed that the differences between *Indolophus* and the other isectolophids are great enough to remove *Indolophus* from the Isectolophidae. He also mentioned that *Indolophus* resembles AMNH 81751 (cf. *Breviodon acares*), but the affinities of *Indolophus* to this specimen are uncertain. The new discovery of the lower and upper teeth of *Indolophus* will give us new information.

The present lower molariform teeth, NMMP-KU 0040 and 0041, has distinct cristid obliqua which originates at posterior trigonid wall more lingually than that in other tapiroids, and relatively narrow trigonid angle in the Tapiroidea. These characteristics are identical to the Asian Lophialetidae such as *Lophialetes*, *Schlosseria*, *Breviodon* and *Kalakotia*. North American isectolophids have larger trigonid angle and buccally shifted cristid obliqua than *Indolophus* and lophialetids. In the Lophialetidae, *Indolophus* most resembles *Schlosseria* in having relatively narrow trigonid angle and the relatively lingual position of the point that cristid obliqua originates on the posterior trigonid wall. In *Indolophus*, trigonid angle is narrower, and trigonid is mesiodistally more compressed than in *Schlosseria*. These comparisons suggest that Indolophus is relatively more primitive than these tapiroids. However, lower molar structure of *Indolophus* is more derived than that of primitive ceratomorph *Orientolophus* (Ting, 1993) from early Eocene of China, because the former is larger, and has comparatively smaller hypoconulid to the hypoconid and entoconid than the latter.

In the upper dentitions, however, *Indolophus* has distinct, large and conical paracone

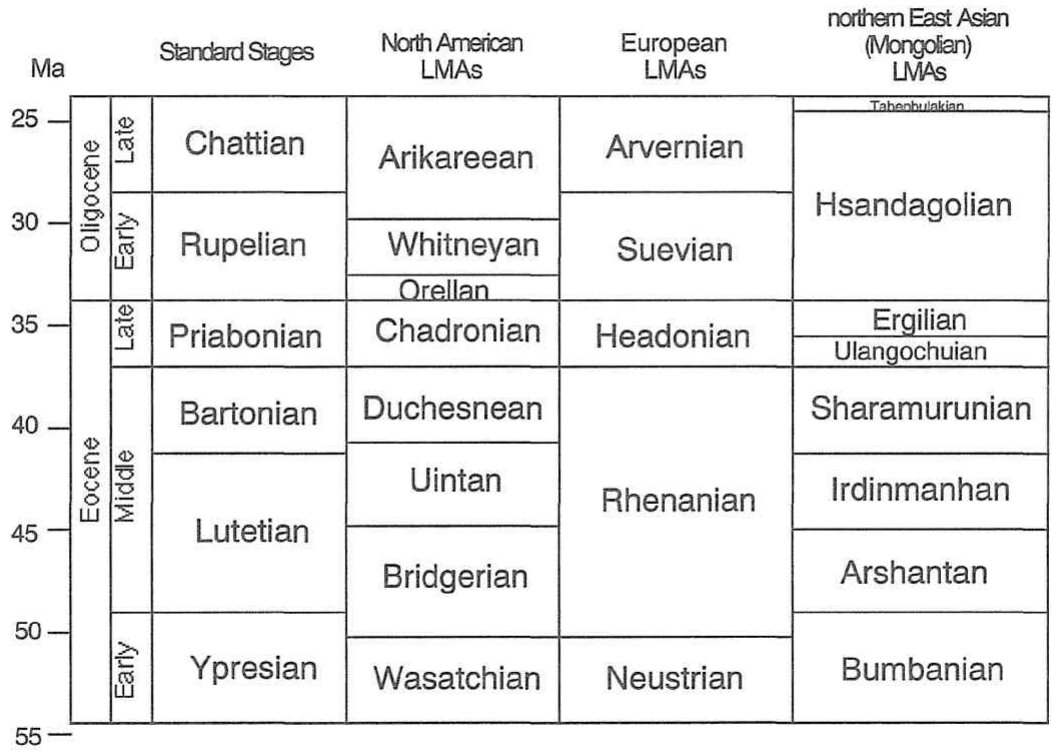

Figure 13. Standard stages and Land Mammal "Ages" (LMAs) of North America, Europe and north Asia (Mongolia). The data of standard stage and North American LMAs are taken from Woodburne and Swisher (1995), those of European LMAs are from McKenna and Bell (1997), and those of northern East Asian (Mongolian) LMAs are from Meng and McKenna (1998).

and metacone on P^{2-4}. This characteristics is similar to the Isectolophidae. On the other hand, lophialetids have smaller paracone and metacone on P^{3-4} than *Indolophus*, and have very vestigial metacone on P^2. The upper molars of *Indolophus* have similarities to those of *Orientolophus*. Both of them have distinct and conical paracone and metacone, more weakly developed lophodonty than isectolophids and lophialetids do. However, *Indolophus* is more derived than *Orientolophus* because the lophodonty in upper molars is more-progressed in *Indolophus*.

Therefore, the evolutionary grade of *Indolophus* is concluded that it is between those of *Orientolophus* and other tapiroids, but the systematic position of *Indolophus* are still uncertain. The Isectolophidae and Lophialetidae have been traditionally included in the Tapiroidea (Romer, 1966; Carroll, 1988, McKenna and Bell, 1997), but recently several workers remove these families from the Tapiroidea to more basal positions of the Ceratomorpha or Moropomorpha (Perissodactyla) separately (Prothero and Schoch, 1989; Janis *et al.*, 1998). More precise phyletic reexamination of the Ceratomorpha and Moropomorpha is needed to clarify the systematic position of *Indolophus*.

Family Deperetellidae Radinsky, 1965

Genus ***Deperetella*** Matthew and Granger, 1925

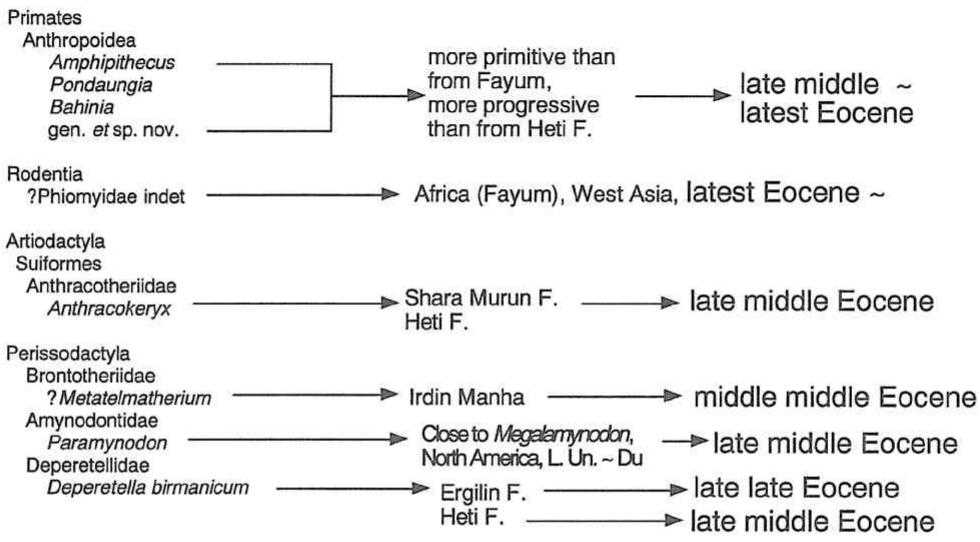

Figure 14. Several Pondaung mammalian taxa from the Pondaung Formation which are useful for estimating the Land Mammal "Age" of the fauna.

Deperetella birmanicum (Pilgrim, 1925) Radinsky, 1965 (Plate 22)

Holotype.—GSI C-348, a left mandible with P_4M_{1-3}.

New material.—NMMP-KU 0005, a left maxillary fragment with roots of P^1, very heavily damaged P^2 and relatively complete P^3; NMMP-KU 0006, a right maxillary fragment with roots of P^1, lingual one-third of P^2 and mesial margin of P^3.

Localities of the new material.—NMMP-KU 0005 was from Bahin area (Figures 1, 5); NMMP-KU 0006 was from Kdw (Figure 7).

Comments.—Descriptions for these material will appear in Tsubamoto *et al.* (submitted). *Deperetella birmanicum* is very closely related to *Deperetella similis* in genus *Deperetella* (Radinsky, 1965; Tsubamoto *et al.*, submitted). The present material from the Pondaung Formation directly indicates that the Pondaung fauna is closely related in age to several middle to late Eocene Chinese and Mongolian faunas which yield *D. similis* or *D.* cf. *similis* (from China), or *D.* cf. *birmanicum* (from Mongolia): Dongjun fauna of Bose Basin, Guangxi Province; Lumeiyi fauna of Lunan Basin and Xiangshan fauna of Lijiang Basin, Yunnan Province; Heti fauna (from the Rencun Member) of Yuanchu Basin, Shanxi and Henan Province; Huangzhuang fauna of Qufu County, Shandong Province; Ergilin Dzo fauna (from the Sevkhul Member) of Khoer Dzan, Mongolia (Figure 2; see Li and Ting, 1983; Russell and Zhai, 1987; Shi, 1989; Zong *et al.*, 1996; Dashzeveg and Hooker, 1997; Huang, 1999). The occurrences of these *D. birmanicum* affinities suggest that these deposits are roughly contemporaneous to each other, and that the mutual biological interchange between these mammal fauna was present (Tsubamoto *et al.*, submitted).

Mammal biostratigraphy

Mammalian faunal list of Krabi

Dermoptera
- Cynocephalidae
  - *Dermotherium major*

Insectivora
- Fam. indet.

Chiroptera
- Megachiroptera
  - Pteropodidae
    - gen. *et* sp. indet.

Primates
- Anthropoidea
  - Propliopithecidae
    - *Wailekia orientale*
    - *Wailekia* sp.
  - Amphipithecidae
    - *Siamopithecus eocaenus*

Carnivora
- Miacidae
  - *Miacis thailandicus*
- ?Mustelidae indet.
- ?Procyonidae indet.
- Nimravidae
  - *Nimravus* cf. *mongoliensis*
- Caniformia indet.

Rodentia
- Ctenodactyloidea indet.
  - Fam. indet. 1
  - Fam. indet. 2

Artiodactyla
- Tayassuidae
  - *Egatochoerus jaegeri*
- Suidae
  - *Siamochoerus banmarkensis*
- Entelodontidae
  - gen. *et* sp. indet.
- Anthracotheriidae
  - *Siamotherium krabiense*
  - *Anthracotherium chaimanei*
  - *Anthracokeryx thailandicus*
  - *Bothriogenys orientalis*
  - *Atopotherium bangmarkensis*
  - Anthracotheriinae
    - gen. *et* sp. nov.
- Ruminantia
  - Lophiomerycidae
    - gen. *et* sp. nov.
  - ?Tragulidae
    - gen. *et* sp. nov.

Perissodactyla
- Helaletidae
  - gen. et sp. nov.
- ?Hyracodontidae
  - gen. *et* sp. nov.

Figure 15-1. Faunal lists of the middle to late Eocene mammal fauna of Southeast Asia at the species level. The Data are based mainly on Li and Tong (1983), Russell and Zhai (1987), Tong (1989) and Ducrocq *et al.* (1995). Additional data are taken from Ducrocq *et al.* (1996), Zong *et al.* (1996), Chaimanee *et al.* (1997), Ducrocq *et al.* (1998), Guo *et al.* (1999) and Huang (1999).

Age of the Pondaung fauna

For the purposes of making chronological correlations among terrestrial deposits bearing mammalian fossils, Land Mammal "Ages" (LMAs) have been often mentioned and used. LMAs of North America and Europe (Figure 13) are now established firmly and in detail (e.g. Woodburne and Swisher, 1995; Steininger *et al.*, 1996). However, Asian LMAs particularly in Paleogene have not been firmly established, because useful data for age determination, such as marine index fossils and radiometric datings, are very poor in the deposits which bear terrestrial mammal fossils in Asia. Recently, Meng and McKenna (1998) established northern East Asian (Mongolian) Paleogene LMAs (Figure 13). But in this paper, three radiometric datings was only the useful data for critical age determination in northern East Asian (Mongolian) Paleogene LMAs. Also, there are many taxonomic problems and confusion about Asian Paleogene mammals. These facts indicate the diffi-

Mammalian faunal list of Dongjun F. (Bose Basin)

Pantodonta
- Coryphodontidae
  - *Eudinoceras crassum*

Carnivora
- Nimravidae
  - *Eusmilus* ? sp.

Acreodi
- Triisodontidae
  - *Andrewsarchus crassum*

Artiodactyla
- Anthracotheriidae
  - *Probrachyodus* ? sp. nov.

Perissodactyla
- Brontotheriidae
  - *Metatelmatherium* sp.
  - cf. Protitan sp.
- Deperetellidae
  - *Deperetella* cf. *similis*
  - *Teleolophus* sp.
- Hyracodontidae
  - *Forstercooperia* sp.
- Rhinocerotidae
  - *Ilianodon* ? sp.
  - *Prohyracodon* sp.
- Amynodontidae
  - cf. *Gigantamynodon* sp.
  - Amynodon sp.
  - cf. *Paramynodon* sp.

Figure 15-2. Dongjung Formation (Bose Basin)

culty in establishing Asian LMAs.

The age of the Pondaung Formation has been inferred based on similarity of occurrences of mammalian taxa from there to those of other Paleogene deposits. The Pondaung fauna has been correlated to Bartonian stage, later part of Uintan of North America or Sharamurunian of Mongolia based mainly on the comparisons of the anthracotheres and brontotheres (Pilgrim and Cotter, 1916; Pilgrim, 1925, 1928; Colbert, 1938; Holroyd and Ciochon, 1994, 1995). Bartonian, later part of Uintan and Sharamurunian are now referred to late middle Eocene (Holroyd and Ciochon, 1994; Figure 13). Here, the Pondaung mammal fauna are compared with other contemporaneous mammal faunas of which ages or LMAs are relatively reliable to discuss the age of the Pondaung fauna.

Figure 14 lists mammalian taxa from Pondaung which are useful for making comparison with other related faunas and for estimating LMAs. Pondaung anthropoids are generally more primitive than the anthropoids from Fayum deposits which are latest Eocene to early Oligocene. The earliest phiomyid rodents have been found from Fayum deposits (Stucky and McKenna, 1993). Cf. *Anthracokeryx* was recorded from the Shara Murun Formation (Sharamurunian) of Mongolia (Meng and McKenna, 1998), and *Anthracokeryx* was also recorded from the Heti Formation of middle part of China, which was generally referred to Sharamurunian (Li and Ting, 1983; Russell and Zhai, 1987). *Metatelmatherium* was recorded from the Irdin Manha Formation (Irdinmanhan) of Mongolia (Li and Ting, 1983; Russell and Zhai, 1987). *Paramynodon* has been suggested to relate very closely to *Megalamynodon* from late Uintan to Duchesnean of North America (Wall, 1989, 1998). *Deperetella* cf. *birmanicum* was recorded from Sevkhul Member (early part of Ergilian) at Khoer Dzan of Mongolia (Dashzeveg and Hooker, 1997), and *Deperetella similis*, which has been suggested to relate closely to *Deperetella birmanicum*, was recorded from the

Mammalian faunal list of Naduo F. (Bose and Yongle Basin)

Placentalia
- Order *et* fam. indet.
  - *Eodesmatodon spanios*

Carnivora
- Hemicionidae
  - *Cephalogale* sp. nov.
  - cf. *Cephalogale* sp.
- Amphicyonidae
  - *Guangxicynodon sinocalifornіae*

Phocoidea
- Fam. indet.
  - *Pachycynodon* ? sp. nov.

Creodonta
- Hyaenodontidae
  - *Propterodon* ? sp.

Acreodi
- Mesonychidae
  - *Guilestes acares*
  - *Guilestes* cf. *acares*
  - cf. *Harpagolestes* sp.

Artiodactyla
- Entelodontidae
  - indet.
- Tayassuidae
  - gen. nov.
- Suidae
  - gen. nov. A
  - gen. nov. B
- ?Choeropotamidae (?Helohyidae)
  - gen. nov.
- Anthracotheriidae
  - *Anthracothema rubricae*
  - *Anthracokeryx birmanicus*
  - *Anthracokeryx moriturus*
  - *Anthracokeryx* sp.
  - *Bothriodon* ? *chyelingensis*
  - *Heothema bellia*
  - *Heothema media*
  - *Huananothema imparilica*

Ruminantia
- ?"Gelocidae"
  - *Notomeryx besensis*
  - *Notomeryx major*
  - *Indomeryx cotteri*
  - *Gobiomeryx* sp.
- Tragulidae
  - indet.

Perissodactyla
- Brontotheriidae
  - *Metatelmatherium* ? cf. *browni*
- Deperetellidae
  - *Deperetella* sp.
- Eomoropidae
  - *Eomoropus* cf. *quadridentatus*
- ?Rhinocerotidae
  - *Huananodon hui*
  - *Guixia simplex*
- Amynodontidae
  - *Caenolophus* sp.
  - *Paramynodon* sp.

Figure 15-3. Naduo Formation.

Heti Formation (Radinsky, 1965; Li and Ting, 1983; Russell and Zhai, 1987; Tsubamoto *et al.*, submitted). These comparisons suggest that the Pondaung fauna is referable to middle middle to late Eocene, and is most probably referred to late middle Eocene (Bartonian). This conclusion agrees with that suggested by Russell and Zhai (1987) and Holroyd and Ciochon (1994, 1995).

However, as mentioned above, LMAs of Mongolia (northern East Asia) is based on only a few reliable evidences for the age determination. Different from marine index fossils, it has been suggested that terrestrial mammals usually need a considerable time to get a wide geological distribution (Walsh, 1998). Therefore, we have to consider some probable time lag when the Asian faunas are compared with other continental faunas. More precise age determination of the Pondaung Formation using radiometric age and marine

Mammalian faunal list of Gongkang F. (Bose and Yongle Basin)

Carnivora
- Felidae
  - Machairodontinae
    - gen. nov.
  - Nimravidae
    - *Haplophoneus* ?

Artiodactyla
- Tayassuidae
  - *Eopecarihyus* sp. nov.
- Anthracotheriidae
  - *Anthracokeryx kwangsiensis*
  - *Anthracokeryx gungkangensis*
  - *Anthracokeryx* sp.
  - *Bothriodon* ? *tientongensis*
  - *Heothema media*
  - *Heothema chengbiensis*
  - *Heothema angusticalxia*

Perissodactyla
- Chalicotheriidae
  - *Schizotherium nabanensis*
  - *Schizotherium* sp.
- ?Rhinocerotidae
  - *Huananodon hypsodonta*
  - *Guixia youjiangensis*
- Hyracodontidae
  - *Forstercooperia* sp. nov.

Figure 15-4. Gongkang Formation.

Mammalian faunal list of lower part of Lumeiyi F. (Lumeiyi-Lunan area)

Creodonta
- indet.

Carnivora
- Nimravidae
  - indet.

Tillodontia
- indet.

Acreodi
- Hapalodectidae
  - *Honanodon* sp.

Artiodactyla
- Helohyidae
  - *Gobiohyus* sp.
- Anthracotheriidae
  - indet.

Perissodactyla
- Brontotheriidae
  - *Protitan* cf. *robustus*
  - *Rhinotitan* sp.
  - indet.
- Lophialetidae
  - *Breviodon lumeiyiensis*
  - *Lophialetes expeditus*
  - *Lophialetes* cf. *expeditus*
  - *Lophialetes yunnanensis*
  - *Rhodopagus pygmaeus*
  - *Rhodopagus minimus*
- Deperetellidae
  - *Deperetella* sp.
  - *Teleolophus* sp.
- Helaletidae
  - *Helatetes mongoliensis*
  - *Hyrachyus lunanensis*
  - *Hyrachyus minor*
- Eomoropidae
  - *Lunania youngi*
- Hyracodontidae
  - *Forstercooperia* sp.
- Rhinocerotidae
  - *Prohyracodon* sp.
- Amynodontidae
  - *Teilhardia pretiosa*
  - *Teilhardia* ? sp.
  - *Caenolophus medius*
  - *Caenolophus* sp.
  - *Lushiamynodon menchiapuensis*
  - *Amynodon lunanensis*
  - *Amynodon* spp.

Figure 15-5. Lower Part of Lumeiyi Formation

index fossils is needed to identify the age of Pondaung fauna and to establish the Asian LMAs.

Comparisons of the Pondaung fauna with the middle to late Eocene mammal fauna of Southeastern Asia

Mammalian faunal lists for eight faunas from the middle to late Eocene deposits of Southeastern Asia are shown in Figure 15. Among the deposits, the Dongjun Formation in

Mammalian faunal list of upper part of Lumeiyi F. (Anyencun-Xiaoshahe area)

Creodonta
- Hyaenodontidae
  - *Pterodon dahkoensis*

Carnivora
- Miacidae
  - *Chailicyon crassidens*
- ?Canidae (?Miacidae)
  - indet.

Artiodactyla
- Entelodontidae
  - *Eoentelodon yunnanense*
- Anthracotheriidae
  - *Probrachyodus panchiaoensis*
  - *Brachyodus ? hui*
  - indet.

Perissodactyla
- Brontotheriidae
  - *Rhinotitan quadridens*
  - *Rhinotitan* sp.
  - *Dianotitan lunanensis*
  - indet.
- Lophialetidae
  - *Breviodon sahoensis*
- Deperetellidae
  - *Deperetella dienensis*
  - *Deperetella* cf. *similis*
  - *Teleolophus medius*
  - *Teleolophus* cf. *magnus*
  - *Teleolophus ? rectus*
- Eomoropidae
  - *Litolophus ? ulterior*
  - *Eomoropus* cf. *quadridentatus*
- Hyracodontidae
  - *Forstercooperia shiwopuensis*
  - *Forstercooperia* sp.
  - *Juxia* sp.
  - *Indricotherium parvum*
  - *Indricotherium* cf. *parvum*
  - *Indricotherium* ? sp.
- Rhinocerotidae
  - *Prohyracodon progressa*
  - *Prohyracodon meridionale*
  - *Prohyracodon* cf. *orientale*
  - *Ilianodon lunanensis*
  - indet.
- Amynodontidae
  - *Amynodon altidens*
  - *Amynodon* sp.
  - cf. *Metamynodon*
  - cf. *Paramynodon*

Figure 15-6. Upper part of Lumeiyi Formation.

the Bose (Baise) Basin is overlain by the Naduo Formation, and the latter is overlain by the Gongkang Formation (Russell and Zhai, 1987); and the Lumeiyi Formation at Lumeiyi-Lunan area in the Lunan Basin is stratigraphically lower than that at Anyencun-Xiaoshahe area (Li and Ting, 1983; Russell and Zhai, 1987; Tong, 1989). Russell and Zhai (1987) suggested that the Naduo and Gongkang faunas should be regarded as a single assemblage.

The Pondaung fauna resembles the Naduo fauna of Bose Basin best among the faunas. Five genus and five species are shared by these two faunas: *Anthracothema rubricae*, *Anthracokeryx moriturus*, *Anthracokeryx birmanicus*, *Indomeryx cotteri*, *Metatelmatherium*? *browni* and *Deperetella*. Higher degree of dominance by artiodactyls including rather progressive types such as the Tayassuidae, Suidae and Tragulidae in the Naduo fauna indicates that this fauna is later in age than the Pondaung fauna. The Krabi fauna of Thailand is highly dominated by artiodactyls including the Tayassuidae, Suidae and ?Tragulidae, and yields very few perissodactyls, indicating that the fauna is also later

Mammalian faunal list of Xiangshan F. (Lijiang Basin)

Creodonta
- indet.
- Hyaenodontidae
  - *Pterodon* ? sp.

Acreodi
- Mesonychidae
  - *Honanodon hebetis*
  - *Honanodon* sp.
  - *Lohoodon lushiensis*

Artiodactyla
- Entelodontidae
  - *Eoentelodon likiangensis*
- Anthracotheriidae
  - *Anthracokeryx sinensis*
  - *Anthracothema lijiangensis*
- ?Leptomerycidae
  - indet.

Perissodactyla
- Brontotheriidae
  - Metatelmatheriinae
    - indet.
- Lophialetidae
  - *Lophialetes* ? sp.
  - *Breviodon lumeiyiensis*
  - *Schlosseria* sp.
  - *Rhodopagus yunnanensis*
  - *Lijiangia zhangi*
- Lophiodontidae
  - *Lophiodon* ? spp.
- Deperetellidae
  - *Deperetella similis*
  - *Teleolophus xiangshanensis*
- Eomoropidae
  - *Lunania youngi*
  - *Eomoropus minimus*
  - *Grangeria canina*
- Rhinocerotidae
  - *Prohyracodon major*
  - *Prohyracodon meridionale*
- Amynodontidae
  - *Amynodon* sp.
  - *Caenolophus* sp.

Figure 15-7. Xiangshan Formation.

in age than the Pondaung fauna. The Caijiachong fauna of Yuezhow Basin yields many artiodactyls, and also yields *Karakoromys* and *Parasminthus* which firstly appeared in Hsanda Gol Svita (Hsandagolian = Oligocene) of Mongolia (Dashzeveg, 1993), indicating that the fauna is also later in age than the Pondaung fauna.

On the other hand, the Dongjun fauna of Bose Basin is characterized by the dominance of Perissodactyla, inferiority of Artiodactyla, and existence of pantodont *Eudinoceras* of which last appearance was Irdinmanhan (Meng and McKenna, 1998), indicating that the fauna is earlier in age than the Pondaung fauna. The lower Lumeiyi fauna of Lunan Basin are characterized by the dominance of Perissodactyla, particularly the Lophialetidae, and existence of helohyid *Gobiohyus* which was found from Irdinmanhan (Meng and McKenna, 1998), indicating that the fauna is earlier in age than the Pondaung fauna.

The upper Lumeiyi fauna of Lunan Basin and the Xiangshan fauna of Lijiang Basin are dominated by perissodactyls, but artiodactyls are increasing. These two are considered to be roughly the same in age as the Pondaung fauna.

However, such comparisons above are very equivocal and have some contradictions. This is because the faunal and taxonomic analysis of Paleogene Asian mammals is far behind that of North America and Europe, and probably because environmental derivation might occur in some degree between northern and southern Asia, as the world was getting

Mammalian faunal list of Caijiachong F. (Yuezhow Basin)

Insectivora
  Dormaaliidae
    indet.
  Erinaceoidea
    indet.

Chiroptera
  Vespertilionoidea
    indet.

?Primates
    indet.

Lagomorpha
    indet.

Rodentia
  Cricetidae
    Eucricetodon sp.
  Ctenodactylidae
    Karakoromys sp.
    Dianomys obscuratus
    Dianomys qujingensis
  Dipodidae
    Parasminthus sp.

Acreodi
  Mesonychidae
    Honanodon hebetis
    Honanodon sp.
    Lohoodon lushiensis

Artiodactyla
  Entelodontidae
    Entelodon sp.
  Anthracotheriidae
    Bothriodon chowi
  ?"Gelocidae"
    cf. *Indomeryx* sp.
  Leptomerycidae
    Miomeryx sp.
  Lophiomerycidae
    Lophiomeryx sp.

Perissodactyla
  Brontotheriidae
    indet.
  Rhinocerotidae
    Prohyracodon sp.
    indet.
  Amynodontidae
    Gigantamynodon giganteus
    Gigantamynodon cf. *giganteus*
    Gigantamynodon sp.
    Cadurcodon ardynensis
    Cadurcodon sp.
    Caenolophus sp.
    cf. *Metamynodon* sp.
  Hyracodontidae
    Indricotherium intermedium
    Indricotherium qujingensis
    Indricotherium sp.

Figure 15-8. Caijiachong Formation.

cooler gradually from late middle Eocene toward the Eocene-Oligocene boundary (e.g. Prothero, 1994).

Conclusion

The Pondaung fauna turned out to have had a more diverse mammal fauna than previously described. The age of the Pondaung mammal fauna is referable from the middle to late Eocene, based on the stratigraphic and marine index fossils. Based on the mammal fauna, it is referred from middle middle to late Eocene, and is most probably referred to late middle Eocene. However, the more precise dating of the Pondaung Formation by using radiometric dating and marine index fossils, and description of the Pondaung mammals are needed to date the Pondaung mammal fauna and to establish Asian Land Mammal "Ages".

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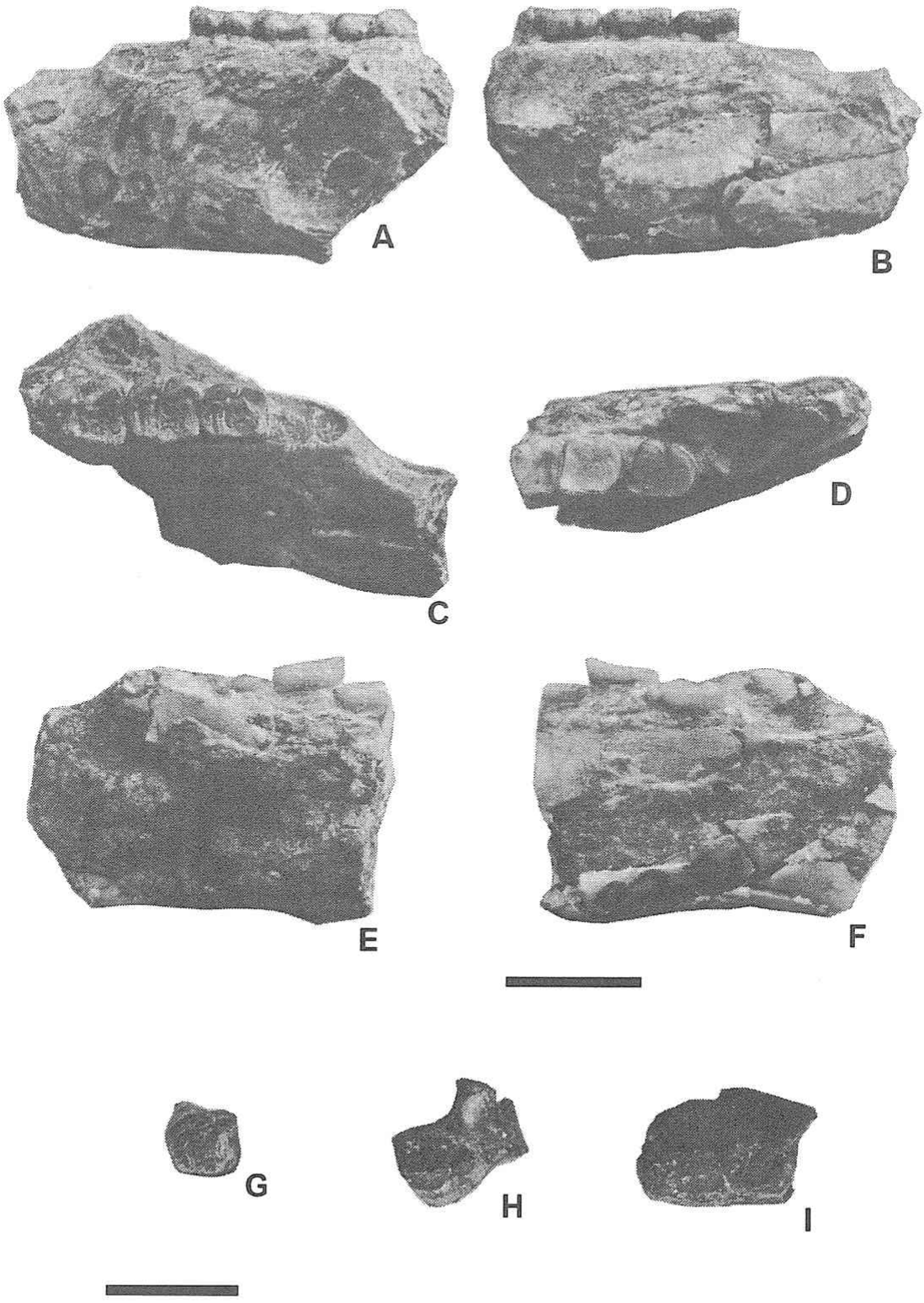


Plate 1. ?Phiomyidae indet. C. **A-C**, NMMP-KU 0213. **D-F**, NMMP-KU 0213. **G**, NMMP-KU 0047. **H**, NMMP-KU 0048. **I**, NMMP-KU 0049. Scale bars = 5 mm (upper scale corresponds to A-F, lower scale corresponds to G-I).

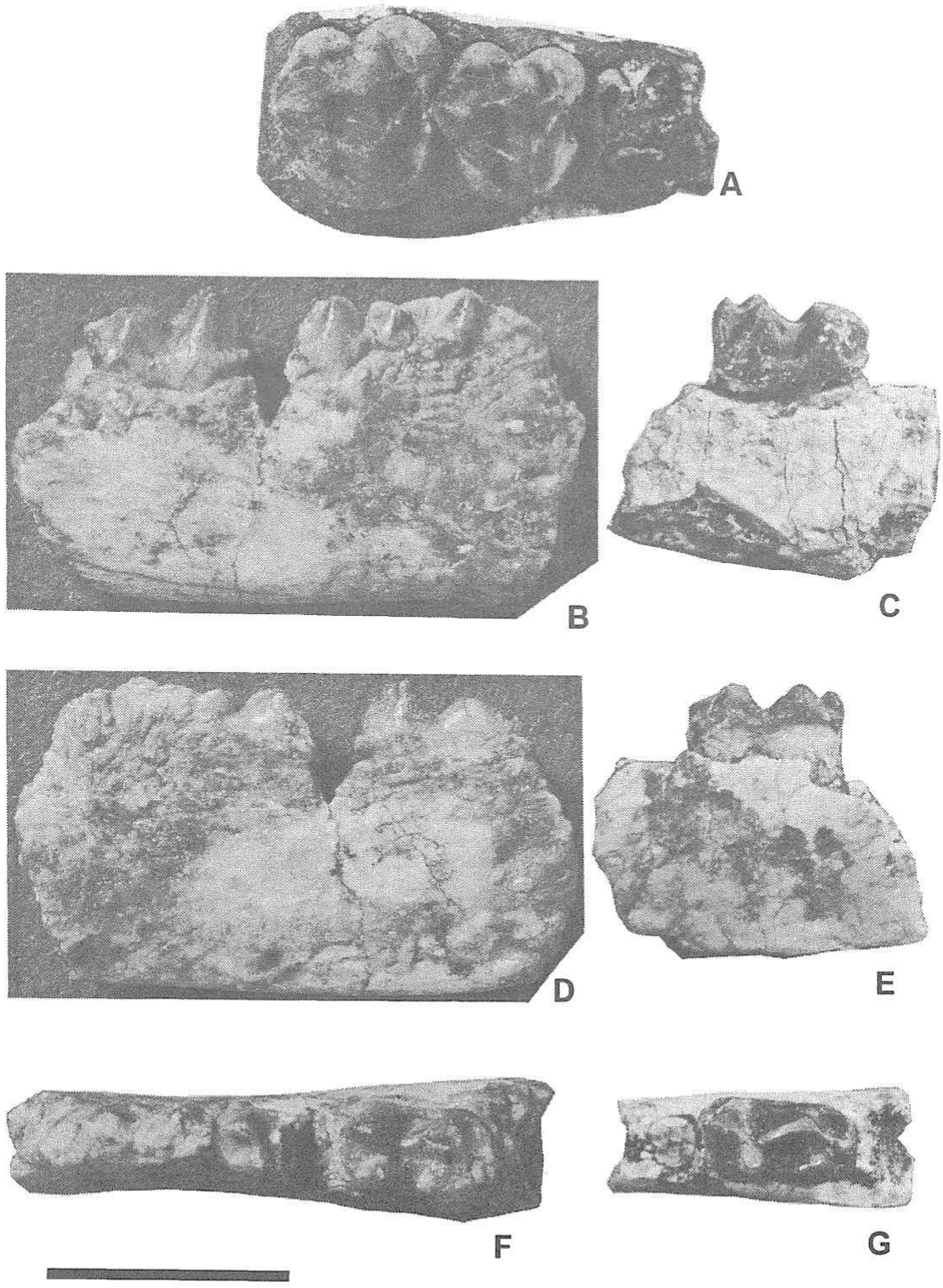


Plate 2. Ungulata indet. D, type 1. **A**, NMMP-KU 0031. **B**, **D**, **F**, NMMP-KU 0037. **C**, **E**, **G**, NMMP-KU 0033. Scale bar = 10 mm.

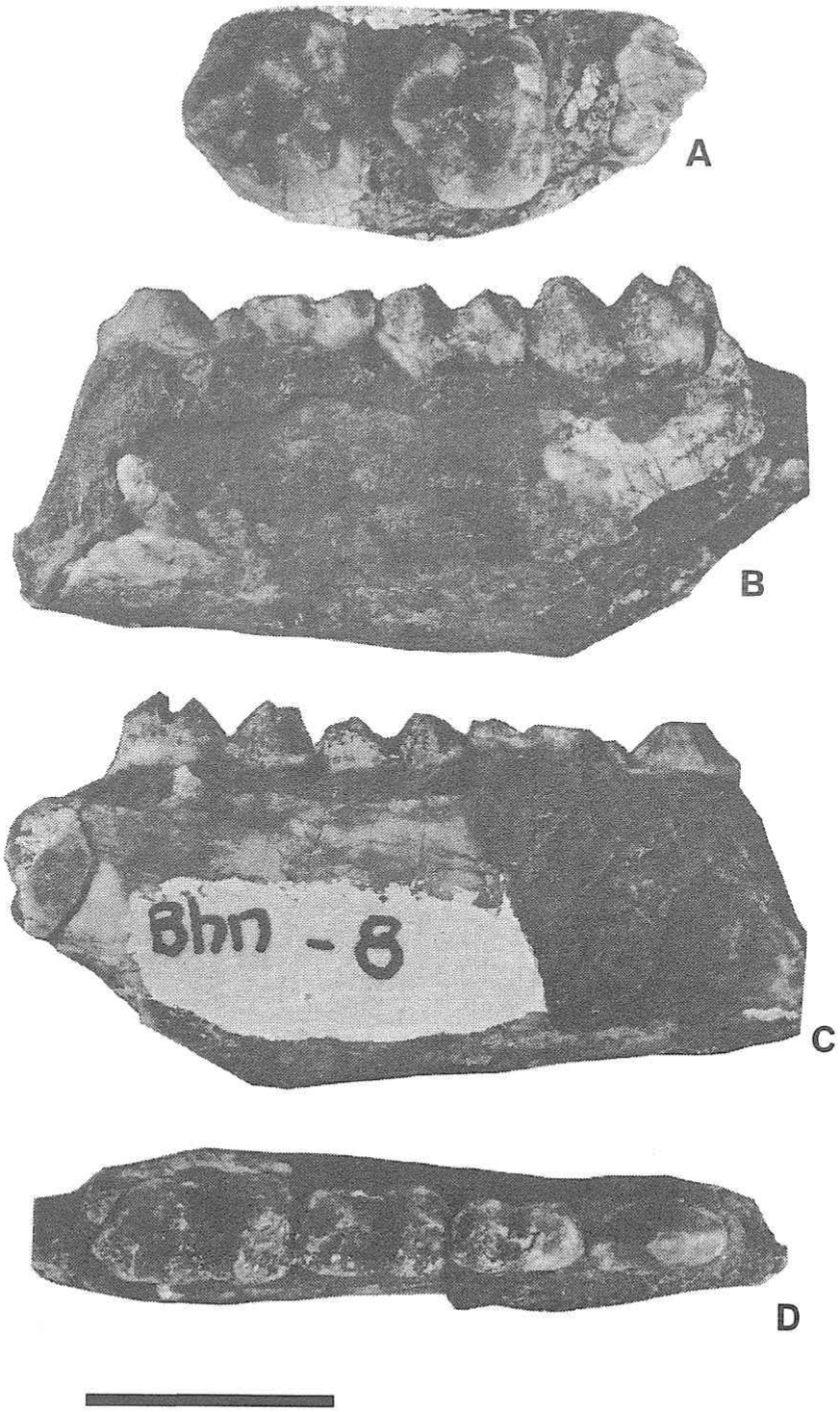


Plate 3. Ungulata indet. D, type 2. **A**, NMMP-KU 0035. **B-D**, NMMP-KU 0036. Scale bar = 10 mm.

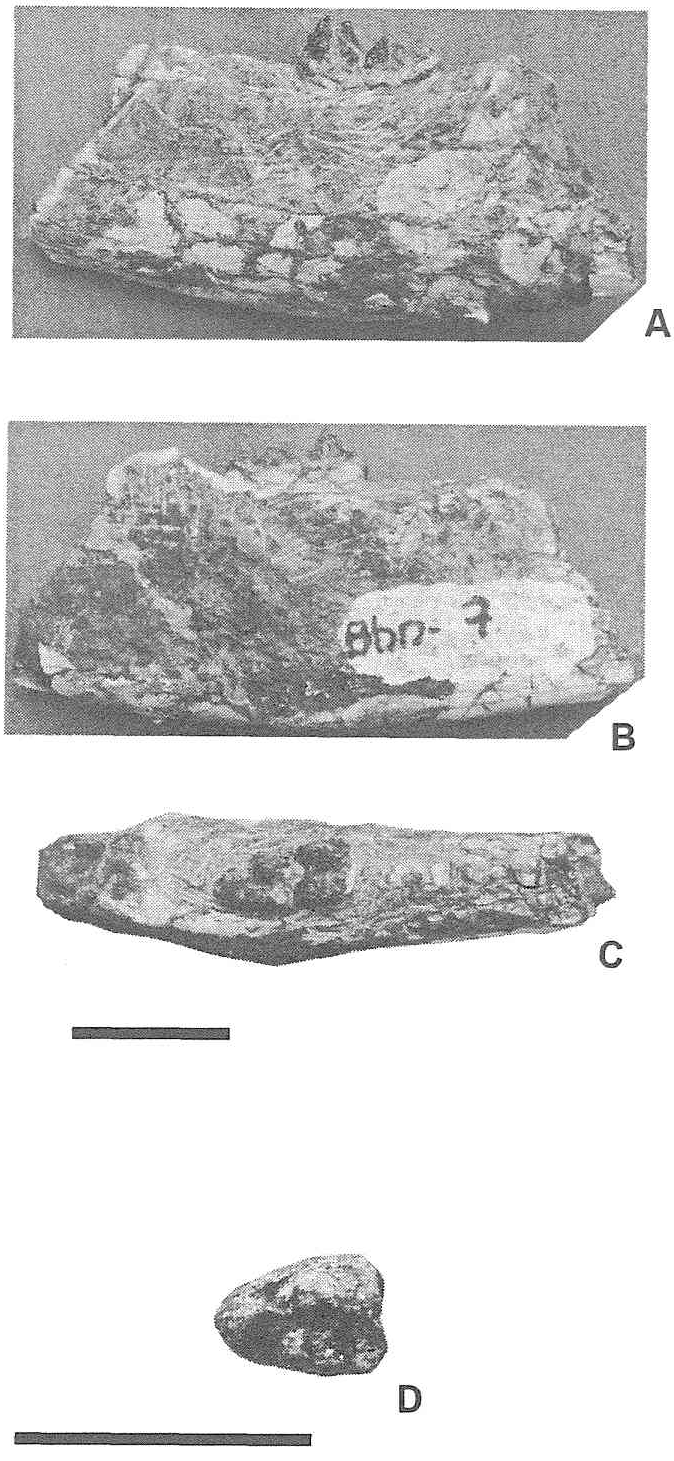


Plate 4. Ungulata indet. D, type 3. **A-C**, NMMP-KU 0032. **D**, NMMP-KU 0034. Scale bars = 10 mm (upper scale corresponds to A-C, lower scale corresponds to D).

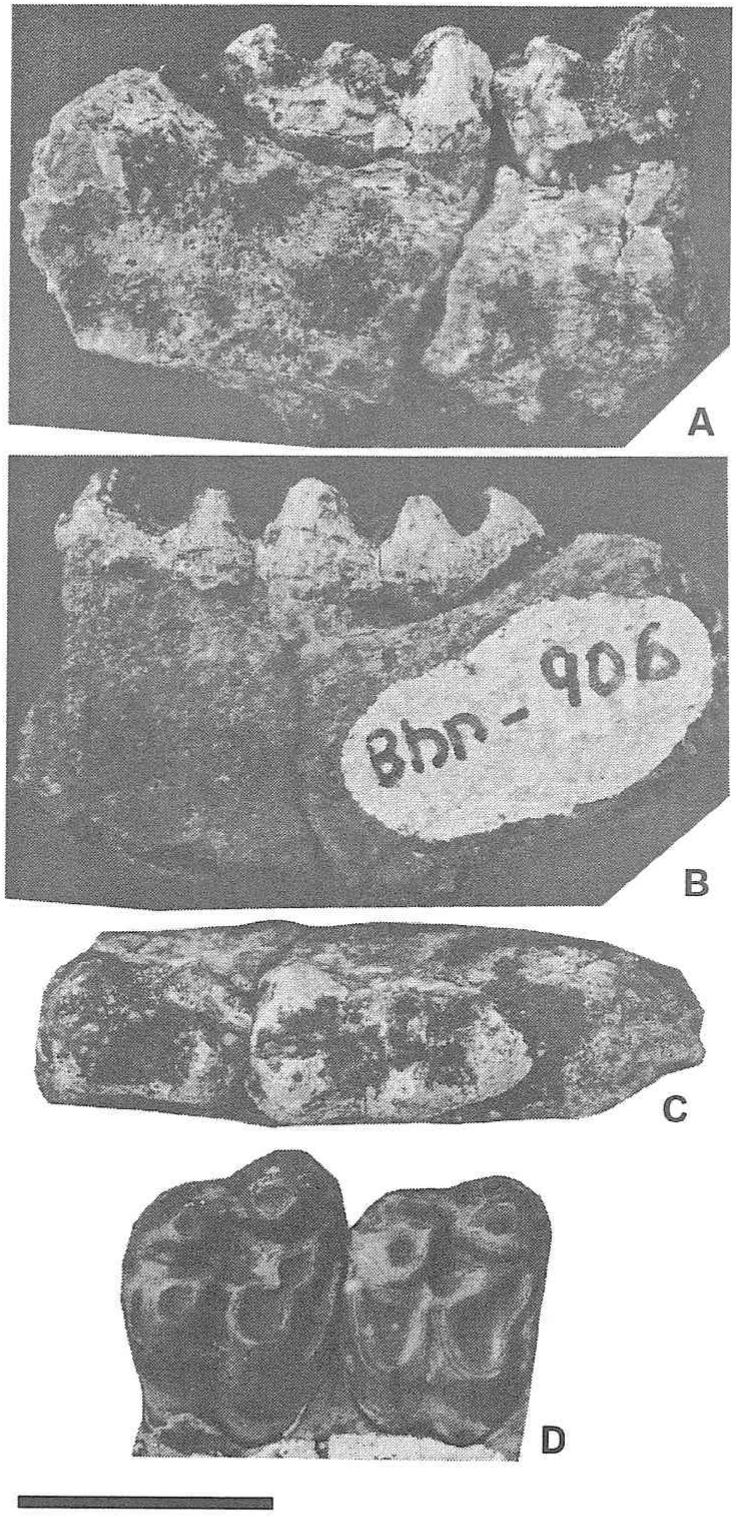


Plate 5. *Pakkokuhyus lahirii*. **A-C**, NMMP-KU 0038. **D**, NMMP-KU 0039. Scale bar = 10 mm.

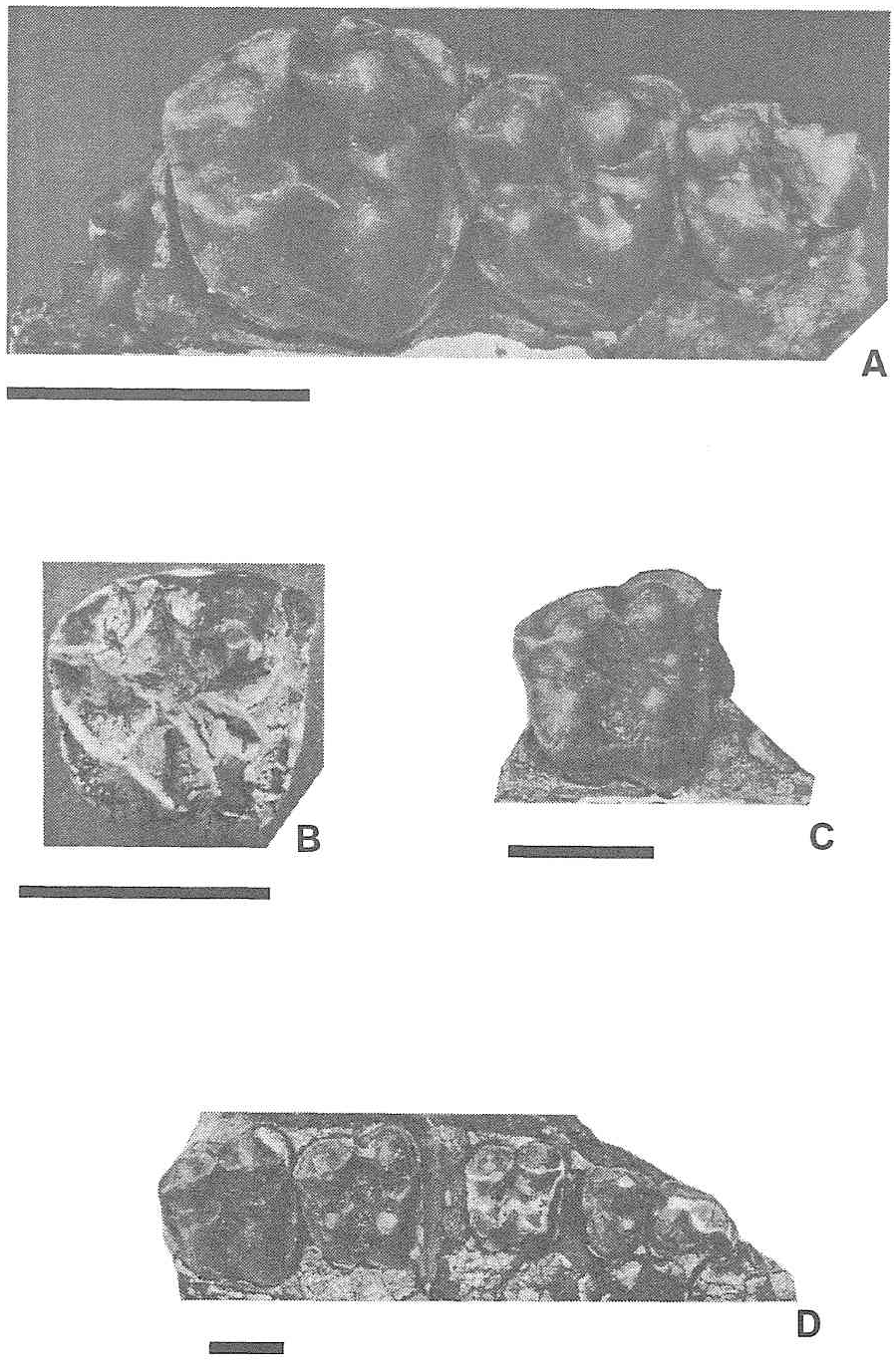


Plate 6. Anthracotheres. **A**, NMMP-KU 0325. **B**, NMMP-KU 0066. **C**, NMMP-KU 0326. **D**, NMMP-KU 0053. Each scale bar = 10 mm for each specimen.

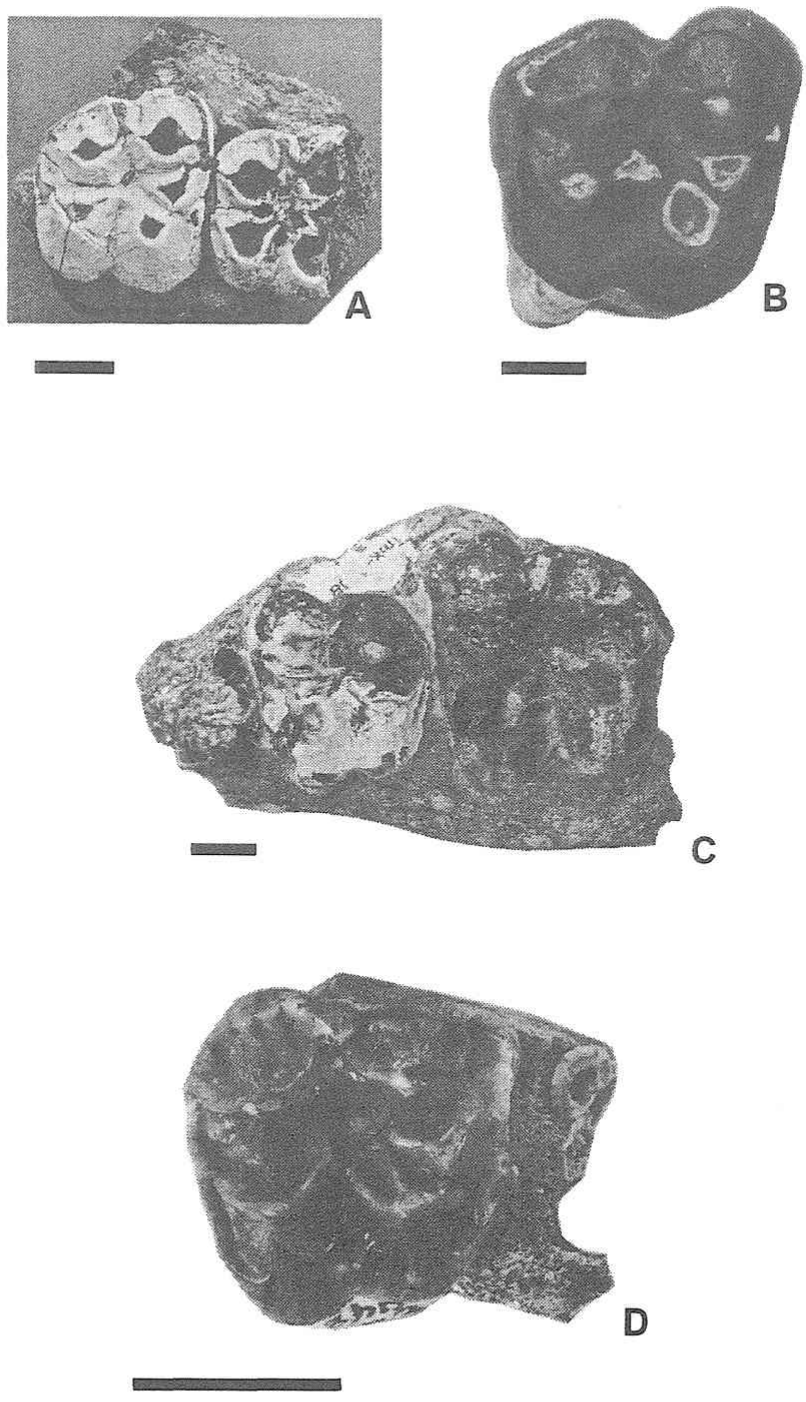


Plate 7. Anthracotheres. **A**, NMMP-KU 0216. **B**, NMMP-KU 0328. **C**, NMMP-KU 0329. **D**, NMMP-KU 0327. Each scale bar = 10 mm for each specimen.

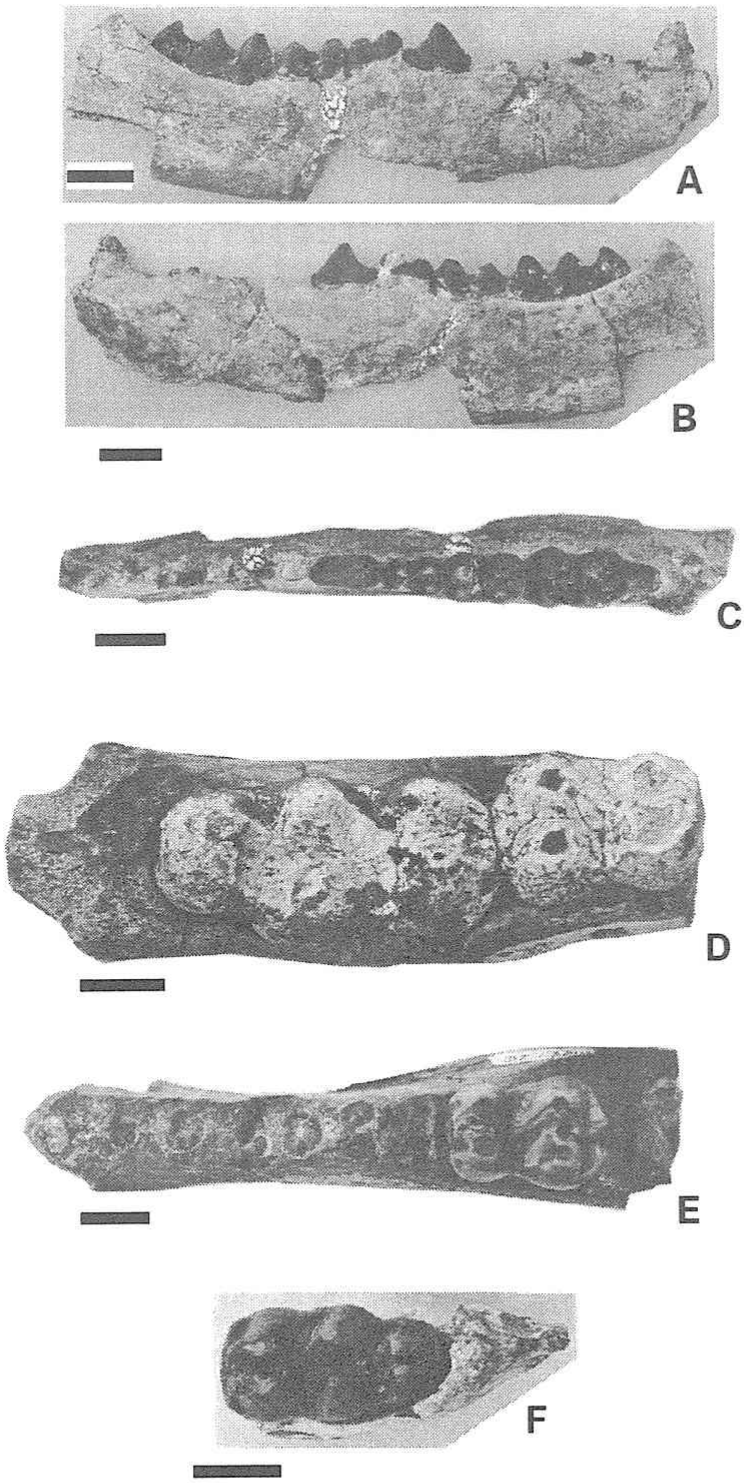


Plate 8. Anthracotheres. **A-C**, NMMP-KU 0052. **D**, NMMP-KU 0330. **E**, NMMP-KU 0331. **F**, NMMP-KU 0332. Each scale bar = 10 mm for each picture.

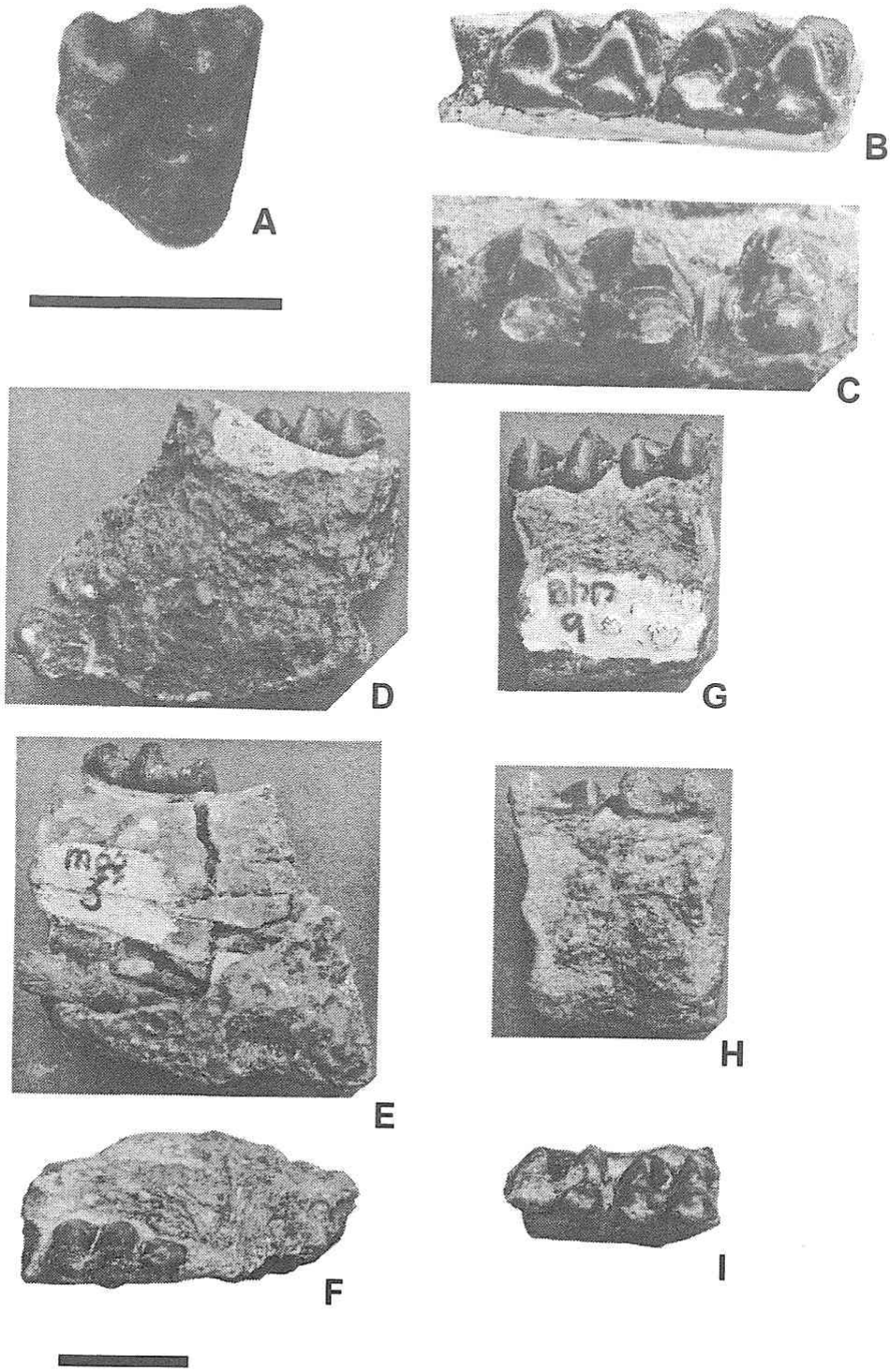


Plate 9. ?Agriochoeridae indet. E. **A**, NMMP-KU 0026. **B**, NMMP-KU 0029. **C**, NMMP-KU 0264. **D-F**, NMMP-KU 0028. **G-I**, NMMP-KU 0027. Scale bars = 10 mm (upper scale corresponds to A-C, lower scale corresponds to D-I).

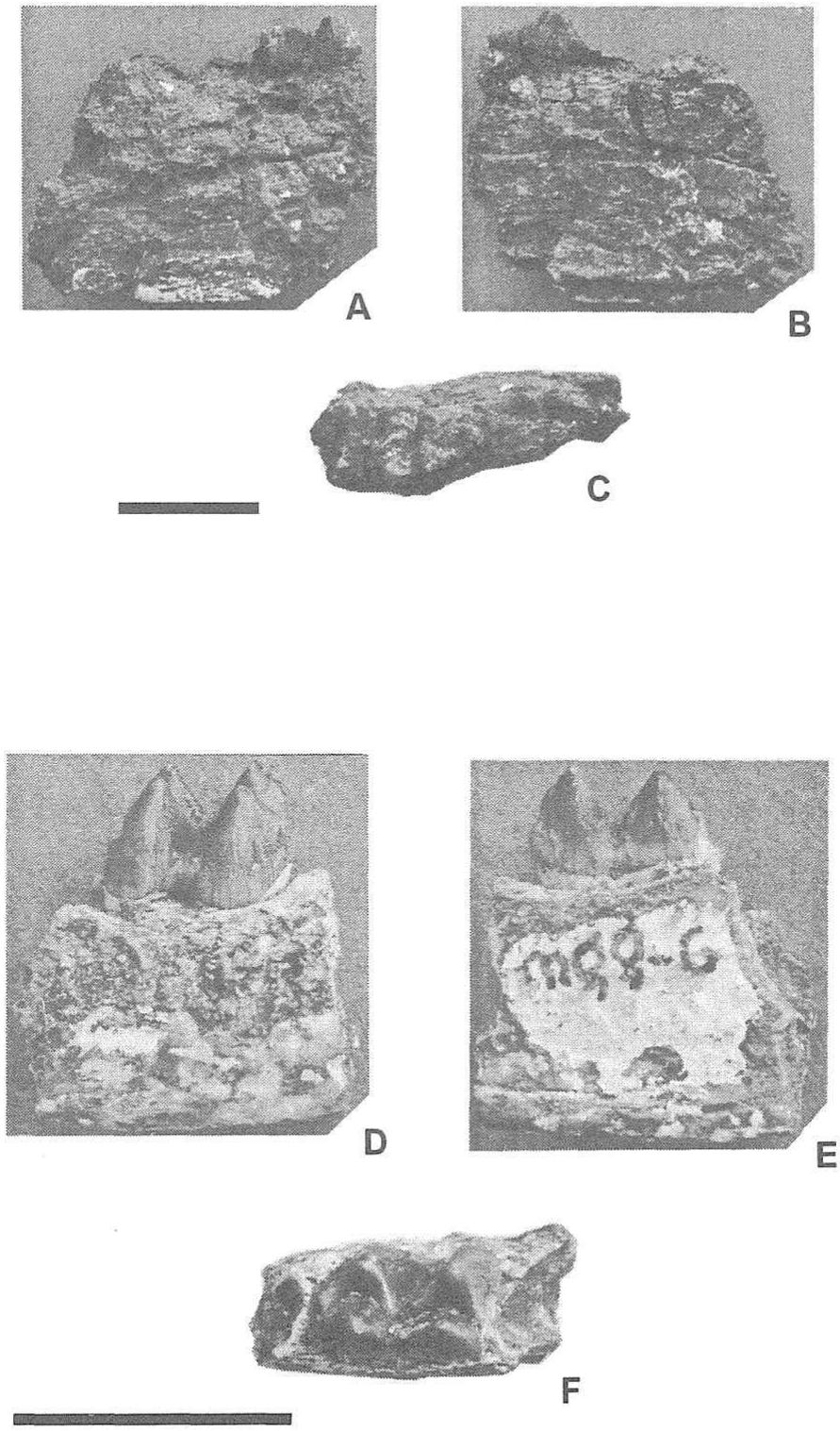


Plate 10. **A-C**, ?Agriochoeridae indet. E, NMMP-KU 0068. **D-F**, cf. ?Agriochoeridae indet. E, NMMP-KU 0030. Scale bars = 10 mm (upper scale corresponds to A-C, lower scale corresponds to D-F).

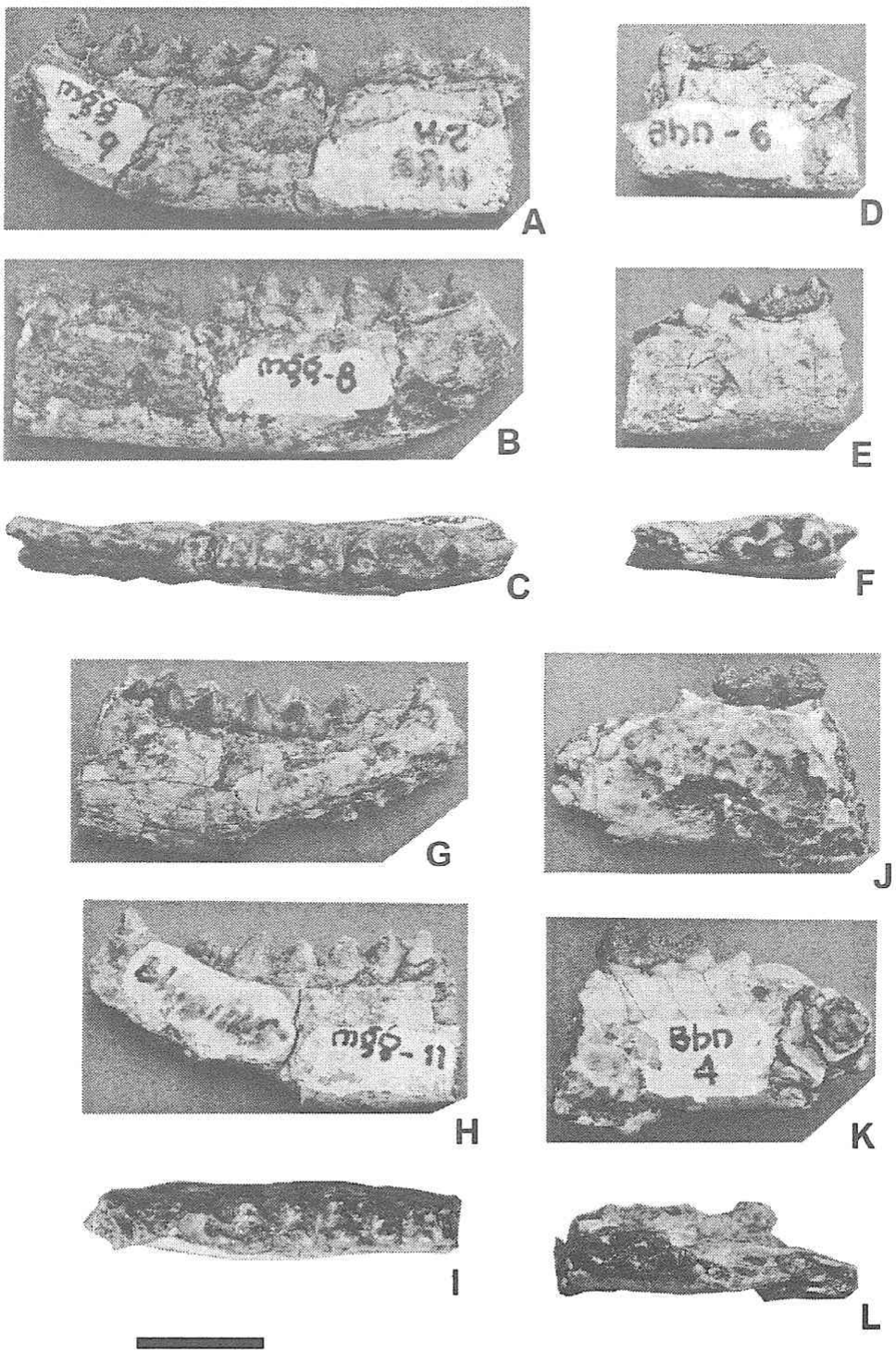


Plate 11. *Indomeryx cotteri*. **A-C**, NMMP-KU 0019. **D-F**, NMMP-KU 0014. **G-I**, NMMP-KU 0016. **J-L**, NMMP-KU 0012. Scale bar = 10 mm.

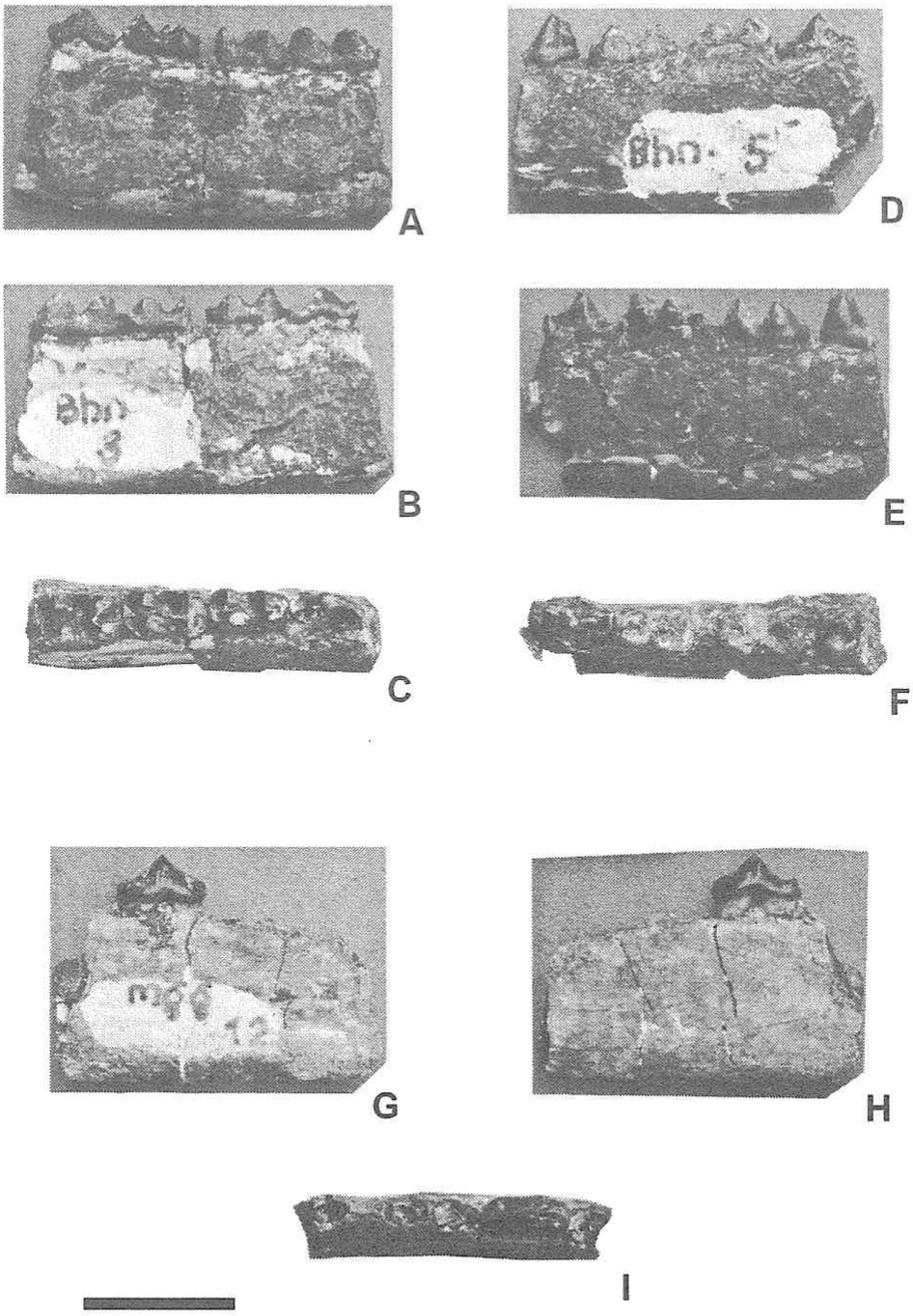


Plate 12. *Indomeryx cotteri*. **A-C**, NMMP-KU 0011. **D-F**, NMMP-KU 0013. **G-I**, NMMP-KU 0021. Scale bar = 10 mm.

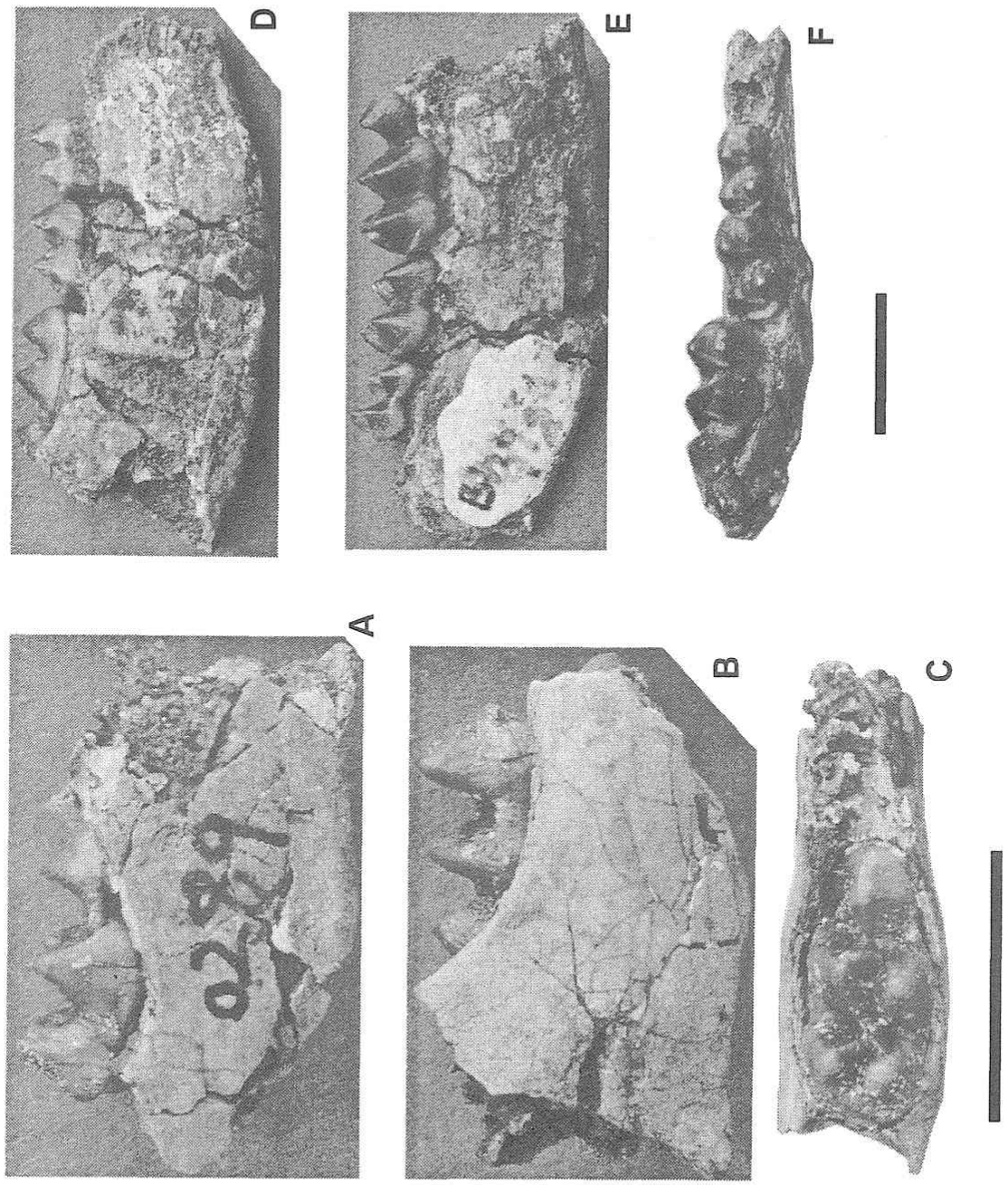


Plate 13. *Indomeryx cotteri*. **A-C**, NMMP-KU 0289. **D-F**, NMMP-KU 0015. Scale bars = 10 mm (left scale corresponds to A-C, right scale corresponds to D-F).

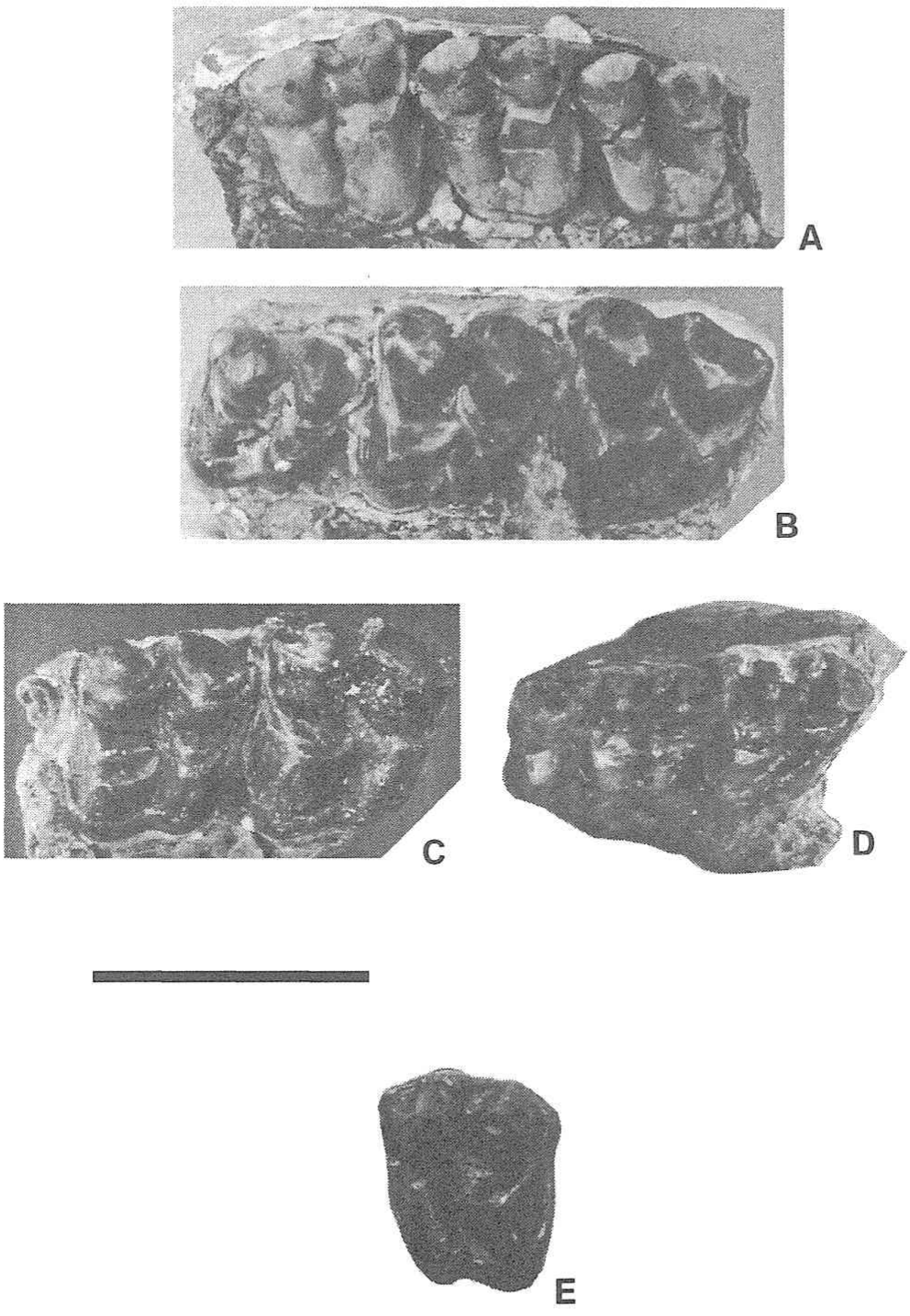


Plate 14. A-D, *Indomeryx cotteri*. A, NMMP-KU 0007. B, NMMP-KU 0008. C, NMMP-KU 0009. D, NMMP-KU 0010. E, cf. *Indomeryx cotteri*, NMMP-KU 0025. Scale bar = 10 mm.

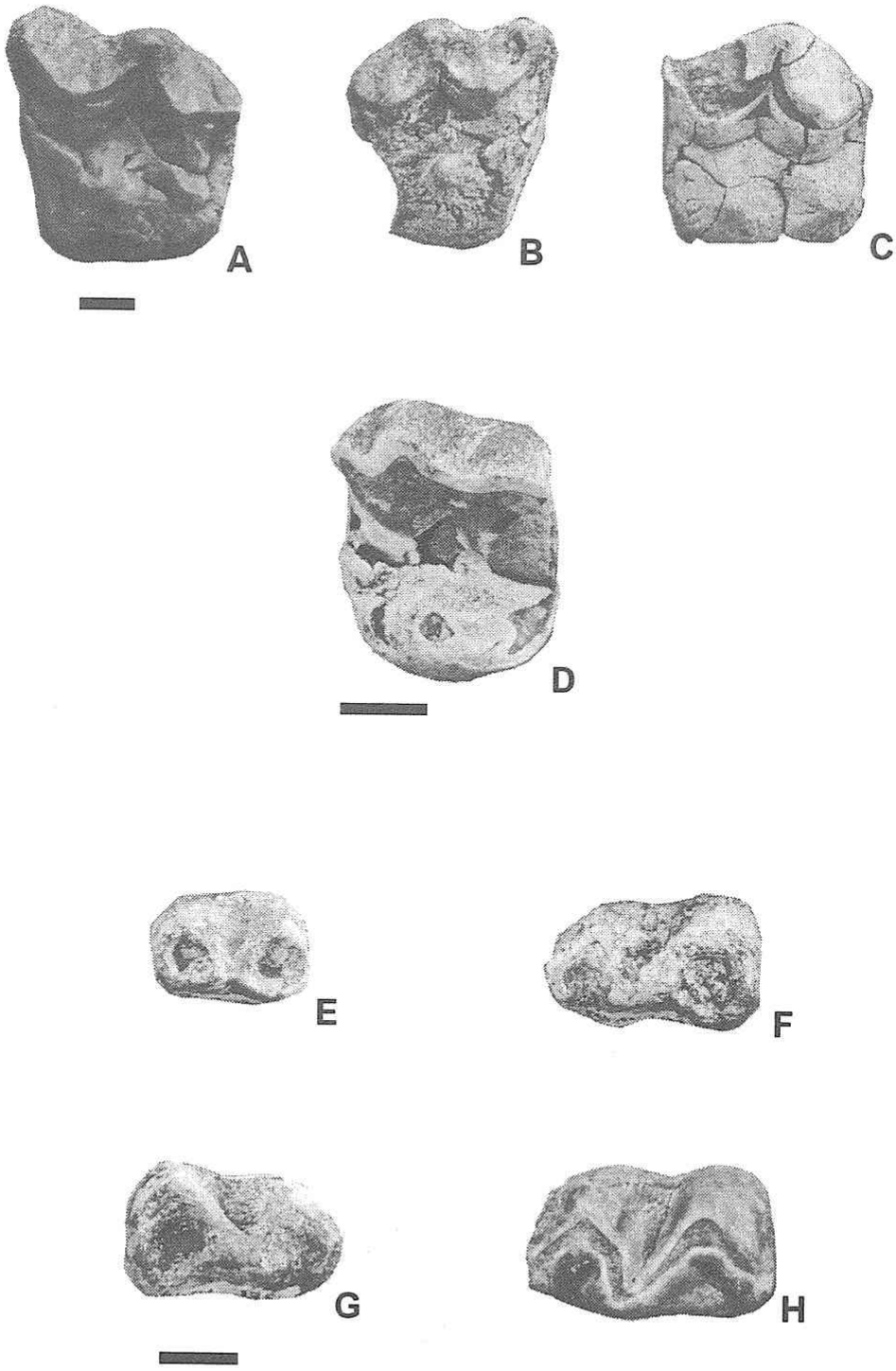


Plate 15. Brontotheres. **A**, NMMP-KU 0312. **B**, NMMP-KU 0313. **C**, NMMP-KU 0319. **D**, NMMP-KU 0320. **E**, NMMP-KU 0321. **F**, NMMP-KU 0322. **G**, NMMP-KU 0323. **H**, NMMP-KU 0324. Scale bars = 10 mm (upper scale corresponds to A-C, middle scale corresponds to D, lower scale corresponds to E-H).

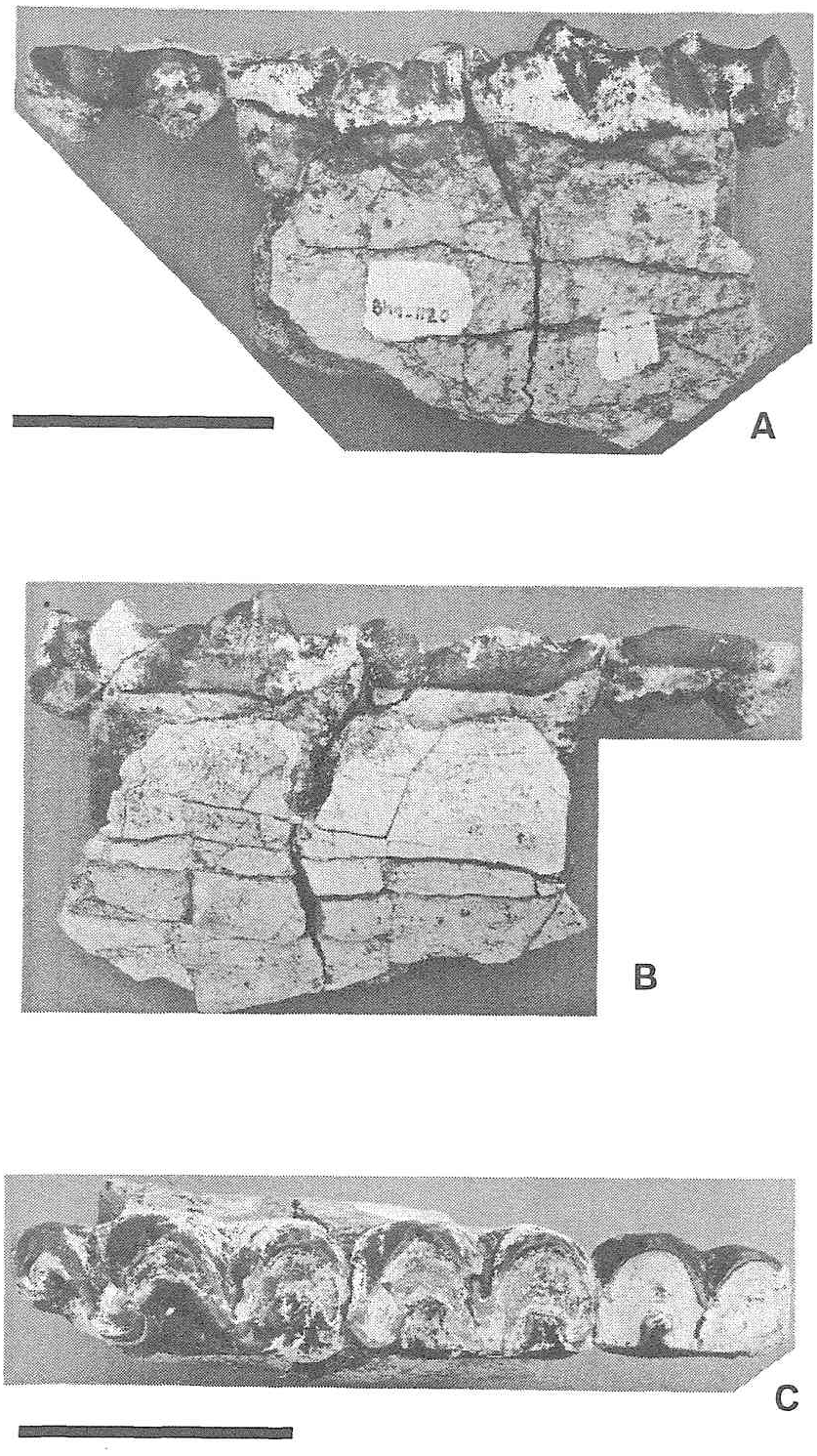
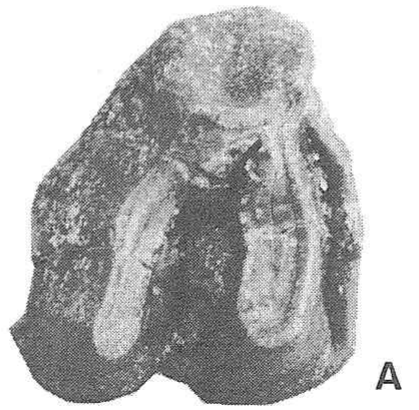


Plate 16. A brontothere. A-C, NMMP-KU 0311. Scale bars = 50 mm (upper scale corresponds to A-B, lower scale corresponds to C).



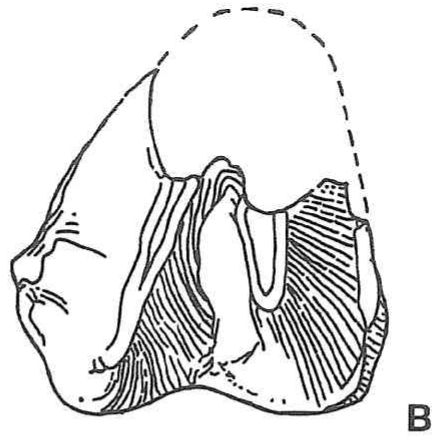
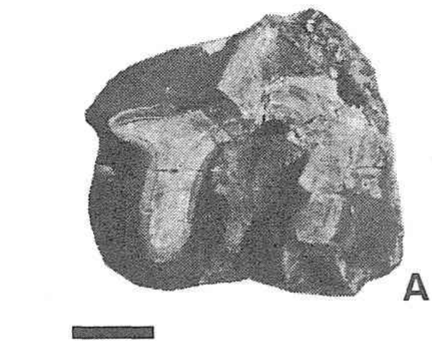
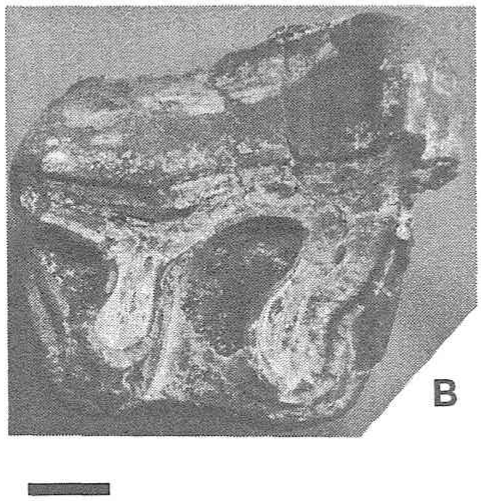


Plate 17. **A**, cf. *Ilianodon lunanensis*, NMMP-KU 0288. **B**, a right M^3 of *Ilianodon lunanensis*, IVPP V.2609.2, from upper part of the Lumeiyi Formation, southern China (after Chow and Xu, 1961). Scale bar = 10 mm.





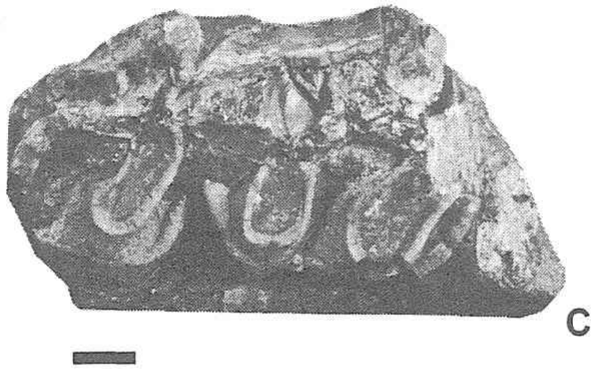


Plate 18. *Paramynodon birmanicus*. **A**, NMMP-KU 0314. **B**, NMMP-KU 0316. **C**, NMMP-KU 0317. Each scale bar = 10 mm for each specimen.

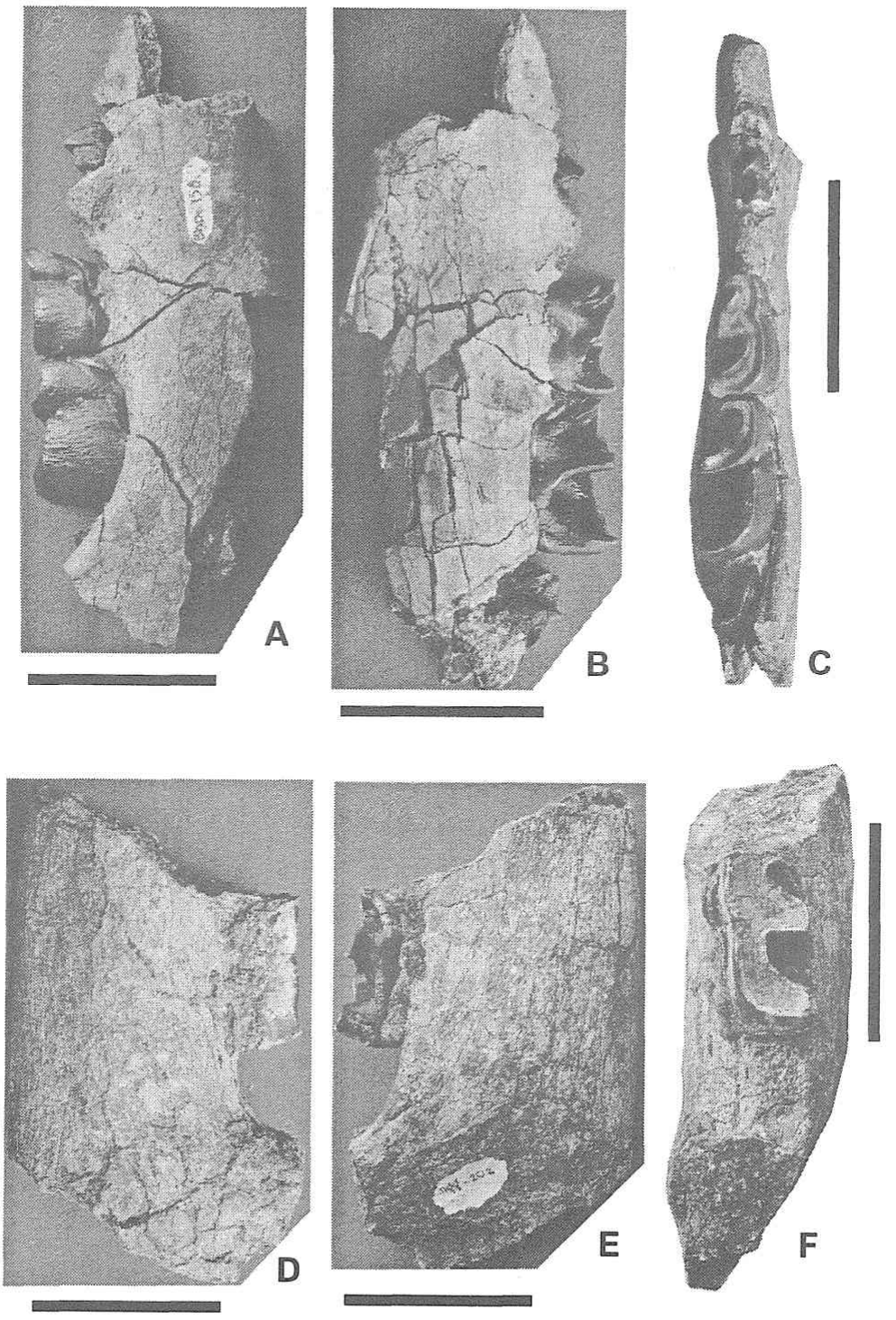
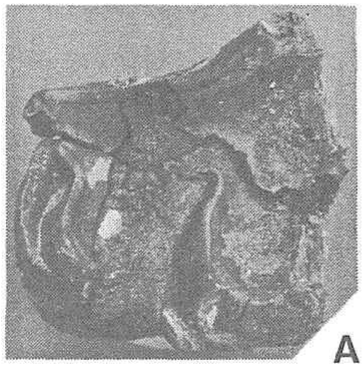
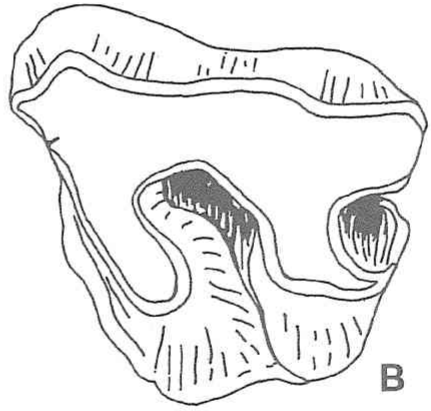


Plate 19. *Paramynodon birmanicus*. **A-C**, NMMP-KU 0315. **D-F**, NMMP-KU 0318. Each scale bar = 50 mm for each picture.



A



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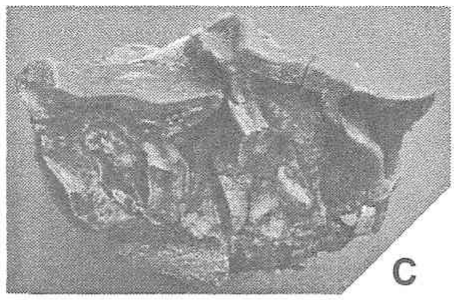
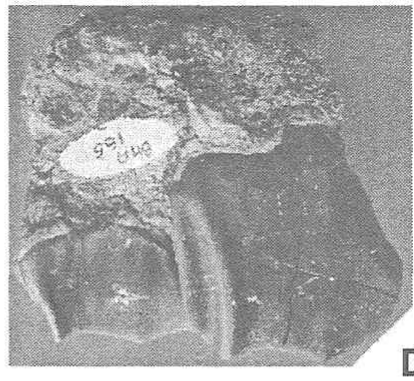


C



D

Plate 20. Amynodontidae indet. F. A, NMMP-KU 0281. B, GSI C328 (after Pilgrim and Cotter, 1916). C-D, NMMP-KU 0305. Scale bars = 10 mm (upper scale corresponds to A-B, lower left scale corresponds to C, lower right scale corresponds to D).

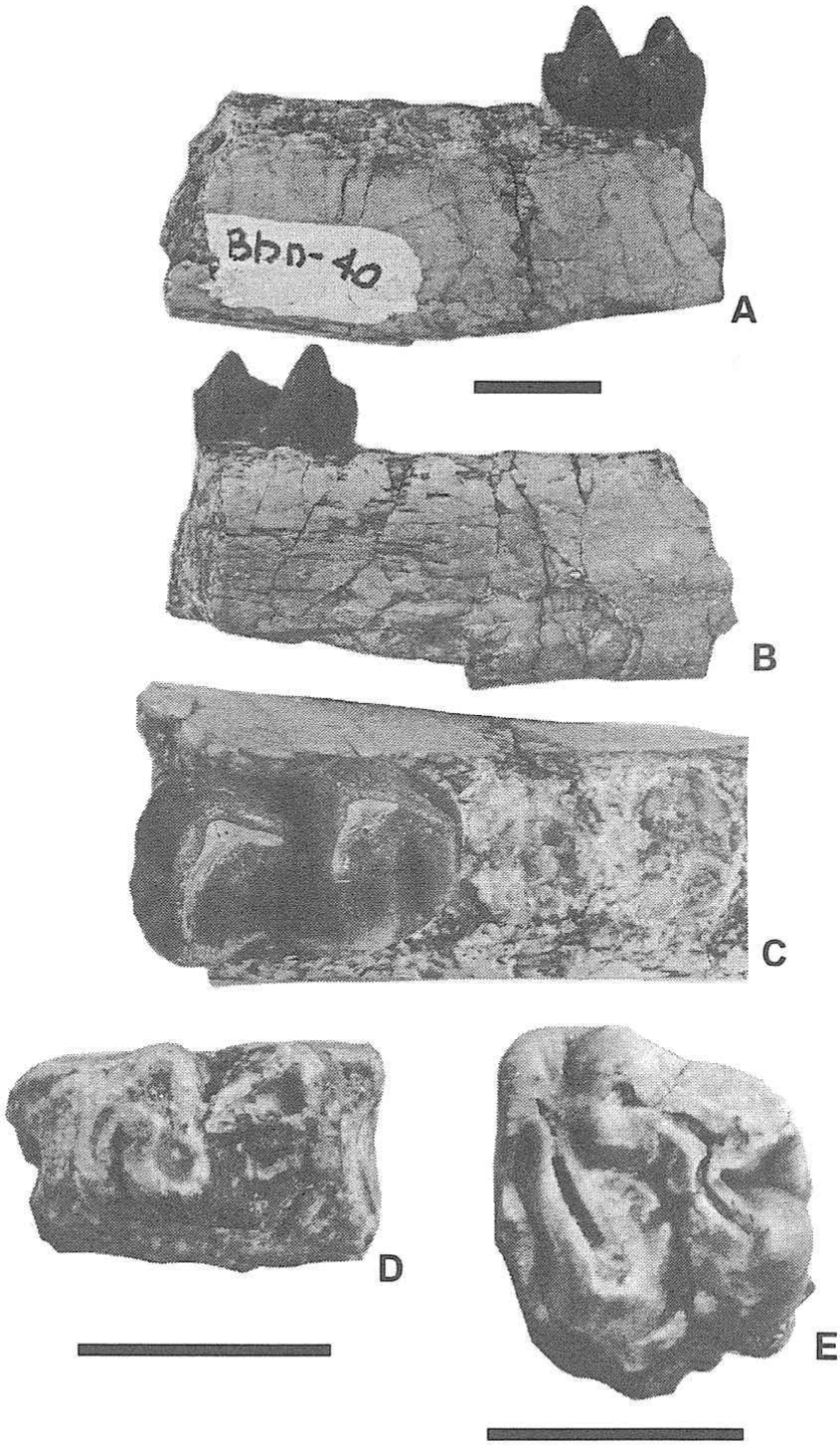


Plate 21. *Indolophus guptai*. **A-C**, NMMP-KU 0040. **D**, NMMP-KU 0041. **E**, NMMP-KU 0265. Scale bars = 10 mm (upper scale corresponds to A-B, lower left scale corresponds to C-D, lower right scale corresponds to E).

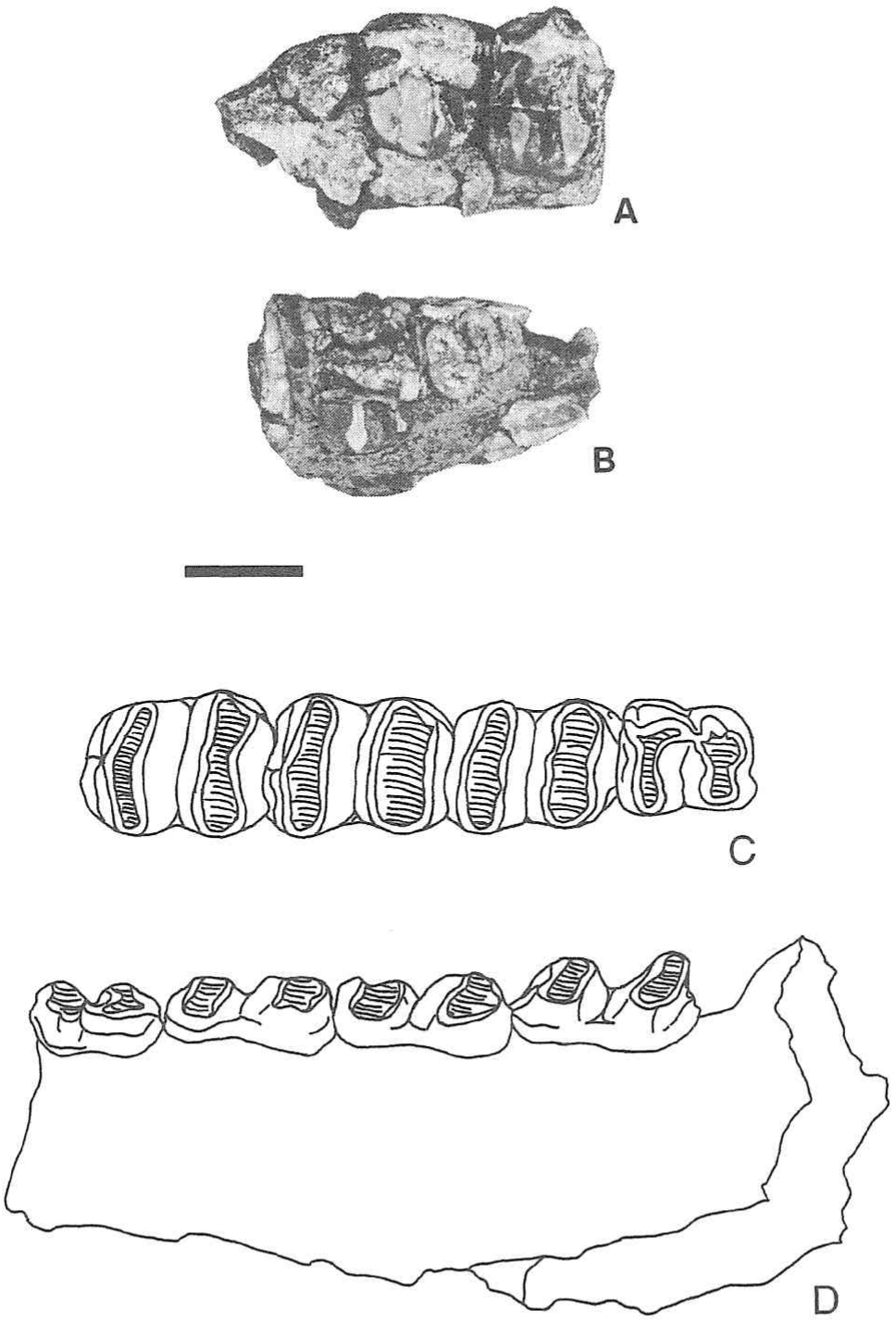


Plate 22. *Deperetella birmanicum*. **A**, NMMP-KU 0005. **B**, NMMP-KU 0006. **C-D**, GSI C-348 (after Colbert, 1938). Scale bar = 10 mm.

Appendix. List of NMMP-KU.

NMMP-KU No.	Identification	Material	Informal number	Locality	Collection year
0001	new primates (unnamed)	max. and mand. with teeth		Bh1	Myanmar-Japan Team, 1998
0002	Primates	mand. with m/3		Bh1	Myanmar-Japan Team, 1998
0003	*Pondaungia cotteri*	upper teeth		PGN2	Myanmar-Japan Team, 1998
0004	Primates	canine		PGN2	Myanmar-Japan Team, 1998
0005	*Deperetella birmanicum*	L max. with LP\1-3	Bhn-1041	Bahin area	Myanmar Team, 1997
0006	*Deperetella birmanicum*	R max. with RP\1-3	Kdw-139	Kdw	Myanmar Team, 1997
0007	*Indomeryx cotteri*	R max. with RM\1-3	Bhn-915	Bahin area	Myanmar Team, 1997
0008	*Indomeryx cotteri*	L max. with LM\1-3	mgg-2	Mogaung area	Myanmar Team, 1997
0009	*Indomeryx cotteri*	L max. with LM\2-3	mgg-14	Mogaung area	Myanmar Team, 1997
0010	*Indomeryx cotteri*	L max. with LdP\3-4M\1	Lema KC (-1@)	Lma	Myanmar-Japan Team, 1998
0011	*Indomeryx cotteri*	L mand. with Lp/4-m/3	Bhn-3	Bahin area	Myanmar Team, 1997
0012	*Indomeryx cotteri*	R mand. with Rm/3	Bhn-4	Bahin area	Myanmar Team, 1997
0013	*Indomeryx cotteri*	R mand. with Rp/4-m/3	Bhn-5	Bahin area	Myanmar Team, 1997
0014	*Indomeryx cotteri*	L mand. with Lm/3	Bhn-6	Bahin area	Myanmar Team, 1997
0015	*Indomeryx cotteri*	L mand. with Lm/1-3	Bhn-913 + 1114	Bahin area	Myanmar Team, 1997
0016	*Indomeryx cotteri*	L mand. with Lm/1-3	Bhn-915 or 1115, mgg-11	Bahin or Mogaung area	Myanmar Team, 1997
0017	*Indomeryx cotteri*	R mand. with Rm/3	mgg-5	Mogaung area	Myanmar Team, 1997
0018	*Indomeryx cotteri*	L mand. with Lm/2-3	mgg-7	Mogaung area	Myanmar Team, 1997
0019	*Indomeryx cotteri*	R mand. with Rp/3-m/3	mgg-8 + 9 + 241	Mogaung area	Myanmar Team, 1997
0020	*Indomeryx cotteri*	L mandible	mgg-10	Mogaung area	Myanmar Team, 1997
0021	*Indomeryx cotteri*	R mand. with Rp/4	mgg-12	Mogaung area	Myanmar Team, 1997
0022	*Indomeryx cotteri*	R mand. with Rp/4	Bh-4 (-1@)	Bh4	Myanmar-Japan Team, 1998
0023	?Agriochoeridae	Rm/x	PGN-1 (-5@)	PGN1	Myanmar-Japan Team, 1998
0024	*Indomeryx cotteri*	R mand. with Rm/1 or 2	Lema KC-3@ (1998.11)	Lma	Myanmar-Japan Team, 1998
0025	cf. *Indomeryx cotteri*	RM\1 or 2	mgg-6? or 9?	Mogaung area	Myanmar Team, 1997
0026	?Agriochoeridae	RM\3 (holotype)	Bh-1-8@ (1998.11)	Bh1	Myanmar-Japan Team, 1998
0027	?Agriochoeridae	R mand. with Rm/2-3	Bhn-9	Bahin area	Myanmar Team, 1997
0028	?Agriochoeridae	R mand. with Rm/3	mgg-3	Mogaung area	Myanmar Team, 1997
0029	?Agriochoeridae	R mand. with Rm/1-2	mgg-4	Mogaung area	Myanmar Team, 1997
0030	cf. ?Agriochoeridae	R mand. with Rm/1 or 2	mgg-6	Mogaung area	Myanmar Team, 1997
0031	Ungulata indet. type. 1	R max. with RM\2-3	Bhn-11	Bahin area	Myanmar Team, 1997
0032	Ungulata indet. type. 3	L mand. with Lm/3	Bhn-7	Bahin area	Myanmar Team, 1997
0033	Ungulata indet. type. 1	R mand. with Rm/2	Bh-1-2@ (1998.11)	Bh1	Myanmar-Japan Team, 1998
0034	Ungulata indet. type. 3 or 1	Lm/3' talonid	Bh-1-6@ (1998.11)	Bh1	Myanmar-Japan Team, 1998
0035	Ungulata indet. type. 2	R max. with RM\1-3	Bhn-10	Bahin area	Myanmar Team, 1997

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0036	Ungulata indet. type. 2	L mand. with Lp/4-m/3	Bhn-8	Bahin area	Myanmar Team, 1997
0037	Ungulata indet. type. 1	R mand. with Rdp/4m/1-2	Bh-1-(4)@ (1998.11)	Bh1	Myanmar-Japan Team, 1998
0038	*Pakkokuhyus lahirii*	R mand. with Rm/2-3	Bhn-906	Bahin area	Myanmar Team, 1997
0039	*Pakkokuhyus lahirii*	R max. with RM\2-3	Kdw-6	Kdw	Myanmar Team, 1997
0040	*Indolophus guptai*	L mand. with Lm/2?	Bhn-40	Bahin area	Myanmar Team, 1997
0041	*Indolophus guptai*	R mand. with Rp/4	Pk-2-(1)@ (1998.11)	Pk2	Myanmar-Japan Team, 1998
0042	Hyaenodontidae	skull and others	Kdw-1	Kdw	Myanmar Team, 1997
0043	Hyaenodontidae	Lm/3	Kdw-2	Kdw	Myanmar Team, 1997
0044	Hyaenodontidae	LI\2-3	Kdw-4	Kdw	Myanmar Team, 1997
0045	Hyaenodontidae	R mand. with Rm/1	Bhn-31	Bahin area	Myanmar Team, 1997
0046	Hyaenodontidae	RM/2?	Bh-1-(3)@ (1998.11)	Bh1	Myanmar-Japan Team, 1998
0047	Rodentia ?Phiomyidae	Lm/2		Wka or Kdw	Myanmar Team, 1997
0048	Rodentia ?Phiomyidae	R max. with RP\3-4?		Wka or Kdw	Myanmar Team, 1997
0049	Rodentia ?Phiomyidae	? L mand. with Lm/2-3		Wka or Kdw	Myanmar Team, 1997
0050	*Indomeryx cotteri*	L mand. with Lm/2-3?	Bh-1-(5)@ (1998.11)	Bh1	Myanmar-Japan Team, 1998
0051	*Pondaungia*	M\x' frag.		Lma	Myanmar-Japan Team, 1998
0052	*Anthracokeryx tenuis*	R mand. with Rp/1p/4-m/3	Bh-1-(1)	Bh1	Myanmar-Japan Team, 1998
0053	*Anthracokeryx birmanicus*	R max. with RP\3-M\3	Pk-1-(1)	Pk1	Myanmar-Japan Team, 1998
0054	*Anthracothema pangan*	Rm/3	Pk Peop. Loc. unknown	Bahin area	Myanmar-Japan Team, 1998
0055	*Anthracothema pangan*	L mand. with Lm/3	Pk Peop. Loc. unknown	Bahin area	Myanmar-Japan Team, 1998
0056	*Anthracothema pangan*	max. with RM\2-3	Sinzwe U Mye Aye	Sze	Myanmar-Japan Team, 1998
0057	Rhinocerotoidea?	Upper molariform tooth	Pk Peop. Loc. unknown	Bahin area	Myanmar-Japan Team, 1998
0058	Rhinocerotoidea?	max. with molariform tooth	Pk-2-1	Pk2	Myanmar-Japan Team, 1998
0059	Brontothere	LM\x	MGGN	MGGN	Myanmar-Japan Team, 1998
0060	*Paramynodon*	Rm/x	MGGN 11/14	MGGN	Myanmar-Japan Team, 1998
0061	*Paramynodon*	L max. with LM\1	Pk-2-2	Pk2	Myanmar-Japan Team, 1998
0062	*Anthracothema pangan*	R mand. with Rm/2?	2km NE from Pakkaung	Bahin area	Myanmar-Japan Team, 1998
0063	*Anthracokeryx tenuis*	RM\1	Pk-2-2@	Pk2	Myanmar-Japan Team, 1998
0064	*?Indomeryx* ?	p/4?	Bh-1-7@	Bh1	Myanmar-Japan Team, 1998
0065	?Rodentia	incisor?	Pk-4-1@	Pk4	Myanmar-Japan Team, 1998
0066	*Anthracokeryx tenuis*	RM\1	Bh-4-2	Bh4	Myanmar-Japan Team, 1998
0067	*Anthracothema rubricae*	LP\4	Bh-1-2	Bh1	Myanmar-Japan Team, 1998
0068	?Agriochoeridae	R mand. with Rm/3	Bh-1-2	Bh1	Myanmar-Japan Team, 1998
0069		teeth frags.	Bh-1-2	Bh1	Myanmar-Japan Team, 1998
0070	*Anthracokeryx birmanicus* ?	RM\3	Bh-1-4	Bh1	Myanmar-Japan Team, 1998
0071	Anthracothere	RP\4M\1	Bh-1-4	Bh1	Myanmar-Japan Team, 1998
0072		teeth frags.	Bh-1-3, (11/6)	Bh1	Myanmar-Japan Team, 1998
0073		teeth frags.	Bh-1-4, (11/7)	Bh1	Myanmar-Japan Team, 1998

(*Continued*)

0074	*Anthracothema pangan*	LP\4	Bh-1-6, (11/11)	Bh1	Myanmar-Japan Team, 1998
0075	mammal	tooth root	Bh-1-6, (11/11)	Bh1	Myanmar-Japan Team, 1998
0076		astragals, digit, etc.	Bh-1, (11/7)	Bh1	Myanmar-Japan Team, 1998
0077	*Anthracothema*	M\x, Rm/3	(11/7)	Bh3	Myanmar-Japan Team, 1998
0078	*Anthracokeryx birmanicus*	Lm/1	Bh-4-2, (11/7)	Bh4	Myanmar-Japan Team, 1998
0079	*Anthracokeryx birmanicus*	Lp/3?	Bh-4-2, (11/7)	Bh4	Myanmar-Japan Team, 1998
0080		teeth frags.	Bh-4-2, (11/7)	Bh4	Myanmar-Japan Team, 1998
0081	*Anthracokeryx birmacium* ?	RM\3	PGN-1-1, (11/12)	PGN1	Myanmar-Japan Team, 1998
0082	*Anthracokeryx birmacium* ?	LM\3	PGN-1-1, (11/12)	PGN1	Myanmar-Japan Team, 1998
0083	*Anthracokeryx birmacium* ?	LM\3	PGN-1-1, (11/12)	PGN1	Myanmar-Japan Team, 1998
0084		teeth frags.		PGN1	Myanmar-Japan Team, 1998
0085	*Anthracothema*	Lm/1?	PGN-1-4, (11/15)	PGN1	Myanmar-Japan Team, 1998
0086	*Anthracothema rubricae*	Lp/4?	PGN-1-4, (11/15)	PGN1	Myanmar-Japan Team, 1998
0087	*Anthracothema rubricae*	Rm/3	PGN-2-1, (11/15)	PGN2	Myanmar-Japan Team, 1998
0088	Anthracothere?	canine?	PGN-2-1, (11/15)	PGN2	Myanmar-Japan Team, 1998
0089		teeth frags.		PGN2	Myanmar-Japan Team, 1998
0090		teeth frags.	(11/14)	MGGN	Myanmar-Japan Team, 1998
0091		Humerus & ulna	PGN1-2, (11/13)	PGN1	Myanmar-Japan Team, 1998
0092	fish	bone		PGN1	Myanmar-Japan Team, 1998
0093	*Anthracokeryx tenuis*	L mand with Lm/3	Lema KC-3, (11/16)	Lma	Myanmar-Japan Team, 1998
0094		mand. condyle	Lema KC-4, (11/17)	Lma	Myanmar-Japan Team, 1998
0095		teeth frags.		Lma	Myanmar-Japan Team, 1998
0096	Brontothere?	incisor?	Lema KC-2, (11/19)	Lma	Myanmar-Japan Team, 1998
0097	Brontothere?	incisor?	Lema KC-1, (11/17)	Lma	Myanmar-Japan Team, 1998
0098	Brontothere?	incisor?	Lema KC-1, (11/17)	Lma	Myanmar-Japan Team, 1998
0099	Brontothere	Upper molariform teeth frag.	Lema KC-1, (11/17)	Lma	Myanmar-Japan Team, 1998
0100	*Paramynodon*	Lm/x'trigonid	Thandaung, (11/18)	Thdn	Myanmar-Japan Team, 1998
0101		teeth frag.	Bh-4-1, (11/11)	Bh4	Myanmar-Japan Team, 1998
0102	*Anthracothema*	LM\1 or 2	(11/14)	MGGN	Myanmar-Japan Team, 1998
0103	*Anthracothema pangan*	RP\4	(11/14)	MGGN	Myanmar-Japan Team, 1998
0104		teeth & bone frags.	11/13, TMK	Tmk	Myanmar-Japan Team, 1998
0105	*Anthracokeryx*	RP\4	11/13, TMK	Tmk	Myanmar-Japan Team, 1998
0106	Anthracothere	LP\3	11/13, TMK	Tmk	Myanmar-Japan Team, 1998
0107	*Anthracokeryx tenuis*	Lp/3	11/13, TMK	Tmk	Myanmar-Japan Team, 1998
0108	?Anthracothere	canine?	11/13, TMK	Tmk	Myanmar-Japan Team, 1998
0109	Brontothere	incisor?	11/13, TMK	Tmk	Myanmar-Japan Team, 1998
0110	?	Metatarsal?	Pk-2, (11/9)	Pk2	Myanmar-Japan Team, 1998
0111	?	Metacarpal	Pk-2, (11/9)	Pk2	Myanmar-Japan Team, 1998

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0112		bones	Pk-2, (11/9)	Pk2	Myanmar-Japan Team, 1998
0113	*Anthracokeryx*	Lp/4	11/10	2 km from paukkaung	Myanmar-Japan Team, 1998
0114		teeth frags.	11/10	2 km from paukkaung	Myanmar-Japan Team, 1998
0115	?Artiodactyla (?Primates)	right femur	Pk-1-3, (11/8)	Pk1	Myanmar-Japan Team, 1998
0116	Anthracothere	mand. with teeth	Pk-1-2, (11/8)	Pk1	Myanmar-Japan Team, 1998
0117	*Anthracokeyx tenuis*	R mand with Rm/3'talonid	Pk-1-2, (11/8)	Pk1	Myanmar-Japan Team, 1998
0118	?	incisor	Pk-1-3, (11/8)	Pk1	Myanmar-Japan Team, 1998
0119	?	incisor	Pk-1-3, (11/8)	Pk1	Myanmar-Japan Team, 1998
0120		teeth & bone frags.	Pk-1-3, (11/8)	Pk1	Myanmar-Japan Team, 1998
0121		teeth frags	Pk-2, (11/9)	Pk2	Myanmar-Japan Team, 1998
0122	Anthracothere	RP\3,4,M\1	Pk-2-2, (11/9)	Pk2	Myanmar-Japan Team, 1998
0123	*Anthracokeryx moriturus* ?	LM\x	Pk-2, (11/9)	Pk2	Myanmar-Japan Team, 1998
0124		teeth& bone frags.	Pk-4, (11/10)	Pk4	Myanmar-Japan Team, 1998
0125	Anthracothere	L mand. with Lp/3-4m/2-3	Pk-5, (11/10)	Pk5	Myanmar-Japan Team, 1998
0126		teeth & bone frags.	Pk-5, (11/10)	Pk5	Myanmar-Japan Team, 1998
0127	Anthracothere	RM\x	Pk-5, (11/10)	Pk5	Myanmar-Japan Team, 1998
0128	Anthracothere	LM\x	Pk-5, (11/10)	Pk5	Myanmar-Japan Team, 1998
0129	*Bahinia*	L mand. with i,c,p,m/1'trigonid	Bh-1-	Bh1	Myanmar-Japan Team, 1998
0130	?Anthracothere	?incisor	(11/15)	PGN2	Myanmar-Japan Team, 1998
0131	small mammal	Rm/3' hyld	(11/15)	PGN2	Myanmar-Japan Team, 1998
0132		large bones		Pk2	Myanmar-Japan Team, 1998
0133		large bones		Bahin area	Myanmar-Japan Team, 1998
0134	Rhinocerotoidea indet.	maxilla with teeth roots		Pangan area	Myanmar-Japan Team, 1998
0135		bones		Pk2	Myanmar-Japan Team, 1998
0136		two bones	(11/15 PM)	PGN1	Myanmar-Japan Team, 1998
0137		bones and teeth frags	(11/12)	PGN1	Myanmar-Japan Team, 1998
0138		bones	(11/11 AM)	Bh4	Myanmar-Japan Team, 1998
0139		two bones	(11/14)	MGGN	Myanmar-Japan Team, 1998
0140		bones	(11/7)	Bh4	Myanmar-Japan Team, 1998
0141		large and small bones	(11/9)	Pk2	Myanmar-Japan Team, 1998
0142		two large bones	(11/10 AM)	Pk4	Myanmar-Japan Team, 1998
0143		bones	(11/7)	Bh1	Myanmar-Japan Team, 1998
0144		bones	(11/6 AM)	Bh1	Myanmar-Japan Team, 1998
0145		small teeth and bones	(11/11 AM)	Bh4	Myanmar-Japan Team, 1998
0146		bones	(11/6 AM)	Bh1	Myanmar-Japan Team, 1998
0147		bones and teeth frags.	(11/14 PM)	PGN2	Myanmar-Japan Team, 1998
0148	snake? lizard?	vertebrae and bones	(11/12)	PGN1	Myanmar-Japan Team, 1998
0149		bones	(11/15 PM)	PGN1	Myanmar-Japan Team, 1998

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0150		bones	(11/11)	Bh4	Myanmar-Japan Team, 1998
0151		three bones		Pk2	Myanmar-Japan Team, 1998
0152		bones	(11/13)	Tmk	Myanmar-Japan Team, 1998
0153		bones	(11/19 AM)	Lma	Myanmar-Japan Team, 1998
0154		bones and teeth frags.	(11/18 AM)	Thdn	Myanmar-Japan Team, 1998
0155		bones and teeth frags.	(11/17 PM)	Lma	Myanmar-Japan Team, 1998
0156		bones	(11/13 PM)	PGN1	Myanmar-Japan Team, 1998
0157		large bones	(11/9)	Pk2	Myanmar-Japan Team, 1998
0158	?Anthracothere	?canine	(11/6)	Bh1	Myanmar-Japan Team, 1998
0159		bones and teeth frags.	(11/6)	Bh1	Myanmar-Japan Team, 1998
0160		bones and teeth frags.	(11/15 AM)	PGN2	Myanmar-Japan Team, 1998
0161		bones	(11/7 AM)	Bh4	Myanmar-Japan Team, 1998
0162		bones and teeth frags.	(11/10 AM)	Pk4	Myanmar-Japan Team, 1998
0163		three bones and a tooth	(11/9)	Pk3	Myanmar-Japan Team, 1998
0164		bones		Bh1	Myanmar-Japan Team, 1998
0165		four bones and a tooth	(11/11 PM)	Bh3	Myanmar-Japan Team, 1998
0166		bones and teeth frags.	(11/7 AM)	Bh3	Myanmar-Japan Team, 1998
0167		bones and teeth frags.	(11/8 AM)	Pk1	Myanmar-Japan Team, 1998
0168		a large bone	(11/17 PM)	Lma	Myanmar-Japan Team, 1998
0169		bones		Bahin area	Myanmar-Japan Team, 1998
0201	*Indomeryx cotteri*	L mand. with Lm/1-3 (broken)	(11/6)	Lma	Myanmar-Japan Team, 1999
0202		teeth frags	(11/6)	Lma	Myanmar-Japan Team, 1999
0203		bone frags	(11/6)	Lma	Myanmar-Japan Team, 1999
0204	fish	bones & teeth	(11/7)	Thdn	Myanmar-Japan Team, 1999
0205	mammal	mand. with teeth roots	(11/7)	Thdn	Myanmar-Japan Team, 1999
0206	mammal & reptile	bones	(11/7)	Thdn	Myanmar-Japan Team, 1999
0207		bones & teeth frags	(11/7)	Thdn	Myanmar-Japan Team, 1999
0208	mammal	bone & teeth frags	(11/8)	Lma	Myanmar-Japan Team, 1999
0209		bone & teth frags	(11/8)	Lma	Myanmar-Japan Team, 1999
0210	*?Anthracokeryx*	astragals	(11/9)	Thdn	Myanmar-Japan Team, 1999
0211	mammal	teeth frags	(11/9)	Thdn	Myanmar-Japan Team, 1999
0212		bones & teeth frags	(11/9)	Thdn	Myanmar-Japan Team, 1999
0213	?Phiomyidae	L mand. with Lm/1-3	(11/13)	Bh1	Myanmar-Japan Team, 1999
0214	Creodonta	lower teeh frags	(11/13)	Bh1	Myanmar-Japan Team, 1999
0215	Anthracothere	RP\3	(11/13)	Bh1	Myanmar-Japan Team, 1999
0216	*Anthracothema*	RM\2-3	(11/13)	Bh1	Myanmar-Japan Team, 1999
0217		bones & teeth frags	(11/13)	Bh1	Myanmar-Japan Team, 1999
0218	mammal	p/x	(11/13)	Bh5	Myanmar-Japan Team, 1999

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0219		bone frags	(11/13)	Bh5	Myanmar-Japan Team, 1999
0220		bone frags (large)	(11/13)	Bh4	Myanmar-Japan Team, 1999
0221		bone frags	(11/13)	Bh2	Myanmar-Japan Team, 1999
0222	*Indomeryx*	R mand. with Rm/2-3	(11/14)	Pk1	Myanmar-Japan Team, 1999
0223		bone frags	(11/14)	Pk1	Myanmar-Japan Team, 1999
0224		teeth frags	(11/14)	Pk1	Myanmar-Japan Team, 1999
0225	?*Paramynodon*	upper teeth	(11/14)	Pk6	Myanmar-Japan Team, 1999
0226		teeth and bone frags	(11/14)	Pk6	Myanmar-Japan Team, 1999
0227		teeth and bone frags	(11/14)	Pk7	Myanmar-Japan Team, 1999
0228	*Amphipithecus*	RP\4M\1-3	(11/15)	Pk2	Myanmar-Japan Team, 1999
0229	*Amphipithecus*	part of skull	(11/15)	Pk2	Myanmar-Japan Team, 1999
0230	small mammal	incisor? canine?	(11/15)	Pk2	Myanmar-Japan Team, 1999
0231	?Phiomyidae	R mand with Rm/1-3	(11/15)	Pk2	Myanmar-Japan Team, 1999
0232	?brontothere or amynodontid	incisor	(11/15)	Pk2	Myanmar-Japan Team, 1999
0233	?*Paramynodon*	P\x	(11/15)	Pk2	Myanmar-Japan Team, 1999
0234	?Anthracothere	canine	(11/15)	Pk2	Myanmar-Japan Team, 1999
0235	?*Praramynodon*	canine?	(11/15)	Pk2	Myanmar-Japan Team, 1999
0236	mammal	tooth	(11/15)	Pk2	Myanmar-Japan Team, 1999
0237	mammal	teeth	(11/15)	Pk2	Myanmar-Japan Team, 1999
0238	fish & crocodile	teeth	(11/15)	Pk2	Myanmar-Japan Team, 1999
0239	mammal	R mand. frag.	(11/15)	Pk2	Myanmar-Japan Team, 1999
0240	?*Indolophus*	lower teeth frags	(11/15)	Pk2	Myanmar-Japan Team, 1999
0241	mammal	mand. frag	(11/15)	Pk2	Myanmar-Japan Team, 1999
0242	mammal	bones	(11/15)	Pk2	Myanmar-Japan Team, 1999
0243		bones from same point	(11/15)	Pk2	Myanmar-Japan Team, 1999
0244		bones	(11/15)	Pk2	Myanmar-Japan Team, 1999
0245		bones from U shige point	(11/15)	Pk2	Myanmar-Japan Team, 1999
0246		useful bones	(11/15)	Pk2 (U shige point)	Myanmar-Japan Team, 1999
0247	large mammal	mand. frag	(11/16)	Pk3	Myanmar-Japan Team, 1999
0248	*Anthracokeryx*	L mand. with Lm/1	(11/16)	Pk3	Myanmar-Japan Team, 1999
0249	mammal	incisor	(11/16)	Pk3	Myanmar-Japan Team, 1999
0250		bones & teeth frags	(11/16)	Pk3	Myanmar-Japan Team, 1999
0251	*Anthracokeryx*	Rm/1	(11/16)	Pk2	Myanmar-Japan Team, 1999
0252	mammal	upper premolar	(11/16)	Pk2	Myanmar-Japan Team, 1999
0253		bones & teeth frags	(11/16)	Pk2	Myanmar-Japan Team, 1999
0254		large bones	(11/16)	Pk2	Myanmar-Japan Team, 1999
0255	mammal	teeth frags.	(11/16)	Pk2	Myanmar-Japan Team, 1999
0256	Creodonta	metatarsal	(11/17)	Pk2	Myanmar-Japan Team, 1999

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0257		bone frags	(11/17)	Pk2	Myanmar-Japan Team, 1999
0258		large bones	(11/17)	Pk2	Myanmar-Japan Team, 1999
0259		bone frags	(11/17)	Pk2	Myanmar-Japan Team, 1999
0260		bones & teeth frags	(11/17)	Pk2	Myanmar-Japan Team, 1999
0261	Hyaenodontidae	R mand with Rp/2-4m/1' talonid	(11/17)	near Thadut, Bahin area	Myanmar-Japan Team, 1999
0262	Hyaenodontidae	Rm/1-2	(11/17)	near Thadut, Bahin area	Myanmar-Japan Team, 1999
0263	Anthracokeryx	L mand. with Lm/3	(11/17)	near Thadut, Bahin area	Myanmar-Japan Team, 1999
0264	?Agriochoeridae	L mand. with Lm/2-3	(11/19)	Mta	Myanmar-Japan Team, 1999
0265	*Indolophus*	LM\3	(11/19)	Mta	Myanmar-Japan Team, 1999
0266	*Indomeryx*	R mand. with Rm/1-2	(11/19)	Mta	Myanmar-Japan Team, 1999
0267	*Anthracokeryx tenuis*	L mand. with Lm/1-2	(11/19)	Mta	Myanmar-Japan Team, 1999
0268	*Indomeryx*	L mand. with Lm/3'talonid	(11/19)	Mta	Myanmar-Japan Team, 1999
0269	Anthracothere	Rm/1 or 2	(11/19)	Mta	Myanmar-Japan Team, 1999
0270	Anthracothere	LM\x (broken)	(11/19)	Mta	Myanmar-Japan Team, 1999
0271	Anthracothere	LM\x	(11/19)	Mta	Myanmar-Japan Team, 1999
0272	*Paramynodon*	LM\3	(11/19)	Mta	Myanmar-Japan Team, 1999
0273	?*Indomeryx*	astragals	(11/19)	Mta	Myanmar-Japan Team, 1999
0274	*Anthracothema*	R mand. with Rp/3,4, m/1	(11/19)	Mta	Myanmar-Japan Team, 1999
0275	*Anthracothema pangan*	RM\3	(11/19)	Mta	Myanmar-Japan Team, 1999
0276	mammal	teeth frags	(11/19)	Mta	Myanmar-Japan Team, 1999
0277	Perissodactyla	astragals	(11/19)	Mta	Myanmar-Japan Team, 1999
0278		bone & teeth frags	(11/19)	Mta	Myanmar-Japan Team, 1999
0279		large bones	(11/19)	Mta	Myanmar-Japan Team, 1999
0280	gastropods		(11/19)	Mta	Myanmar-Japan Team, 1999
0281	Amynodontidae indet.	RM\3	(11/19)	PGN1	Myanmar-Japan Team, 1999
0282	brontothere	Rp/x	(11/19)	PGN1	Myanmar-Japan Team, 1999
0283		tooth & bone	(11/19)	PGN1	Myanmar-Japan Team, 1999
0284	*Anthracothema*	RM\3	(11/20)	PGN2	Myanmar-Japan Team, 1999
0285	large mammal	incisor?	(11/20)	PGN2	Myanmar-Japan Team, 1999
0286		bones & teeth frags	(11/20)	PGN2	Myanmar-Japan Team, 1999
0287	*Anthracothema*	LM\x	(11/21)	Mta	Myanmar-Japan Team, 1999
0288	Rhinocerotoidea indet.	RM\3	(11/21)	Mta	Myanmar-Japan Team, 1999
0289	*Indomeryx*	R mand. with Rm/3	(11/21)	Mta	Myanmar-Japan Team, 1999
0290	*Indomeryx*	L mand. with Lm/x,x+1	(11/21)	Mta	Myanmar-Japan Team, 1999
0291	large mammal	incisor	(11/21)	Mta	Myanmar-Japan Team, 1999
0292	mammal	Lp/x	(11/21)	Mta	Myanmar-Japan Team, 1999
0293	mammal	teeth frags	(11/21)	Mta	Myanmar-Japan Team, 1999
0294		bones & teeth frags	(11/21)	Mta	Myanmar-Japan Team, 1999

(*Continued*)

0295	*?Paramynodon*	large bones & teeth	(11/21)	Mta	Myanmar-Japan Team, 1999
0296	Brontohthere	half of M\x	(11/8)	Lma	Myanmar-Japan Team, 1999
0297		bones	(11/17-21)	Pk2	Myanmar-Japan Team, 1999
0298	mammal	incisor	(11/19 or 21)	Mta	Myanmar-Japan Team, 1999
0299	mammal	teeth frags	(11/19 or 21)	Mta	Myanmar-Japan Team, 1999
0301	Hyaenodontidae	Lc/1	Kdw-3	Kdw	Myanmar Team, 1997
0302	Hyaenodontidae	Rc/1	Kdw-5	Kdw	Myanmar Team, 1997
0303	carnivorous mammal	part of L mand.	Tudw-1	Tudw	Myanmar Team, 1997
0304	Hyaenodontidae	L max. with M\1	mgg-1	Mogaun area	Myanmar Team, 1997
0305	Amynodontidae indet.	L max. with ?M\1-2?	Bhn-165	Bahin area	Myanmar Team, 1997
0306	*Anthracothema*	Rp/3 or 2?		?	Myanmar Team, 1997
0307	*Anthracothema*	Lp/4		?	Myanmar Team, 1997
0308	*?Anthracothere*	incisor? canine?		?	Myanmar Team, 1997
0309	*?Sivatitanops*	RM\x frag.		?	Myanmar Team, 1997
0310	*?Paramynodon*	Rm/x' trigonid		?	Myanmar Team, 1997
0311	*Metatelmatherium ? browni*	L mand. with Lm/1-3	Bhn-1120	Bahin area	Myanmar Team, 1997
0312	*Brontothere*	LM\3	Bhn-67	Bahin area	Myanmar Team, 1997
0313	*Brontothere*	RM\3	Bhn-1080	Bahin area	Myanmar Team, 1997
0314	*Paramynodon*	RM\3	Bhn-142	Bahin area	Myanmar Team, 1997
0315	*Paramynodon*	R mand. with Rp/3m/1-3	Bhn-158	Bahin area	Myanmar Team, 1997
0316	*Paramynodon*	RM\2	Bhn-1091	Bahin area	Myanmar Team, 1997
0317	*Paramynodon*	R max. with RM\2-3	mgg-24	Mogaung area	Myanmar Team, 1997
0318	*Paramynodon*	L mand. with Lm/3	mgg-202	Mogaung area	Myanmar Team, 1997
0319	*Brontothere*	L upper molariform tooth	Kdn-1	Kdn	Myanmar Team, 1997
0320	*Brontothere*	LP\4?	Bhn-140	Bahin area	Myanmar Team, 1997
0321	*Brontothere*	Rp/2 or 3?	Bhn-72	Bahin area	Myanmar Team, 1997
0322	*Brontothere*	Rp/3 or 4?	Bhn-108	Bahin area	Myanmar Team, 1997
0323	*Brontothere*	Lp/3 or 4?	Bhn-136	Bahin area	Myanmar Team, 1997
0324	*Brontothere*	Rp/4?	Czn-1	near Chaungzongyi	Myanmar Team, 1997
0325	*Anthracokeryx tenuis*	R max. with RdP\3-4M\1-2	Bhn-19	Bahin area	Myanmar Team, 1997
0326	*Anthracokeryx*	R max. with RM\3 or 2	Bhn-24	Bahin area	Myanmar Team, 1997
0327	*Anthracothere*	R max. with RdP\4	Bhn-53	Bahin area	Myanmar Team, 1997
0328	*Anthracothma*	RM\3	mgg-23	Mogaung area	Myanmar Team, 1997
0329	*Anthracothma*	L max. with LM\1-3	Tmk-18	Tmk	Myanmar Team, 1997
0330	*Anthracothma*	L mand. with Lm/2-3	Bhn-56	Bahin area	Myanmar Team, 1997
0331	*Anthracothma*	R mand. with Rm/2	mgg-20	Mogaung area	Myanmar Team, 1997
0332	*Anthracothere*	R mand. with Rm/3	Tudw-30	Tudw	Myanmar Team, 1997